The Scottish Journal of Agriculture

VOLUME XII

1929

EDINBURGH:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
120 George Street, Edinburgh; Adastral House, Kingsway, London, W.C. 2;
York Street, Manchester; 1 St. Andrew's Crescent, Cardiff;
15 Donegall Square West, Belfast;
or through any Bookseller.

The Scottish Journal of Agriculture.

VOL. XII.—No. 1.] JANUARY 1929. PRICE 1s. NET.

LIVE STOCK IMPROVEMENT AND LIVE STOCK SHOWS.

Professor J. A. SCOTT WATSON, M.C., B.Sc.,
Oxford University.

IN this country we spend, one way and another, a good deal of time, money and effort on the business of live stock improvement. We have some seventy or eighty Breed Societies, making this their main object. We have Milk Recording Societies, Horse Breeding Acts, Premium Bull schemes, and so forth; and we have some hundreds of Show Associations, generally devoting the greater part of their funds to the same end. It is worth while now and again to ask ourselves whether all our effort is being wisely directed and all our money wisely spent. It is the purpose of the present article to examine this question in so far as concerns our Live Stock Shows.

It may of course be said that the proof of the pudding is in the eating, that our existing organisations have proved their value. Nobody can deny that this country can point to a great record of achievement in stock breeding. It is not too much to say, for example, that our meat-producing breeds, whether of cattle, sheep or swine, stand unrivalled throughout the world; at all events the new countries, with the world to choose from, have unanimously adopted our breeds in preference to those from other sources. With dairy stock our success has been at least respectable; for if among the world's dairy breeds we must grant pride of place to the Friesian, we may yet lay claim to the next four or five positions in the list. Our horses, if they are not everywhere first in popular favour, have everywhere won a certain measure of esteem.

We must not forget, however, that we had a long start over our competitors. We had a big home market for live stock products long before such a market developed elsewhere. We started our Herd Books and our Shows a generation or more before other countries thought of such things; and we cannot hope, except by continued strenuous efforts, to retain our initial advantage.

Breeders of pedigree stock sometimes console themselves with the thought that there is something unique in the combination

of natural conditions of this country, something that tends to the production of live stock of exceptional quality. It is supposed that the finest of our strains are subject, under other conditions, to an inevitable process of deterioration. One often hears it said that, however many good specimens of this or that breed are taken by overseas buyers, those buyers will in due time feel obliged to return for more. But this is a vain hope. It is true, of course, that good stock, transferred to a new and less favourable environment, may fail to show its true quality. But the deterioration is apparent rather than real; it affects the individual and not the breed. The only thing that can lead to real deterioration is a lack of skill or care on the part of the breeders, and it is obvious that the skill of our overseas competitors is no longer to be rated low. Indeed competent judges tell us that already there are as good Herefords in the United States as in England, as good Romney Marsh sheep in New Zealand as in Kent, as good beef Shorthorns in Argentina as in Aberdeenshire. At the least, then, other people can imitate our methods and repeat our successes.

Another and more serious problem is presented by the poor quality of much of our commercial stock. Overseas visitors, if they are candid, often express surprise at this. Aware as they are of the high quality of our exports, they come with the expectation of finding every other farmer a pedigree breeder, and the other half owners of highly improved grade or cross-bred herds. What they do find is an astonishing proportion of mongrels and of nondescripts. Of course it would be absurd to deny that there is good stock of certain classes in certain districts. But there are few areas where all the types—beef and dairy stock, sheep, pigs and horses—are uniformly of good quality, and there are too many where the general average is bad. Moreover the average is improving at a lamentably slow speed; indeed it is possible, without being an inveterate pessimist, to doubt if it is really improving at all. Our draft horses undoubtedly have bigger feet and closer action than those of a generation ago. It is less certain whether they work harder or live longer or eat less. Our meat animals come to the block at earlier ages, but at smaller weights and with more intensive feeding; there are no experimental results to show that they make larger or more economical live weight increments.

If it be true that we have a plentiful supply of high class pedigree stock in the country, it ought to be an easy matter to bring about a rapid grading up of our commercial flocks and herds. It ought to be a matter of obvious self-interest for the plain farmer to use a good pedigree sire, always supposing that such can be obtained at a reasonable price; and prices for pedigree sires are on the whole very moderate; at least it is notorious that pedigree breeders, as a class, do not make extravagant profits. But the plain farmer is often quite unconvinced about the merits of pedigree stock from his own strictly commercial point of view. He has no confidence in the aims and methods

of pedigree breeders. Often he has been confirmed in his opinion by bitter personal experience—has bought perhaps choice pedigree heifers that gave no milk, show gilts that were hopelessly unprolific, highly bred sheep that produced weak and puny lambs. Probably he may admit that an infusion of pedigree blood, made with discretion and for a particular purpose, may be advantageous. But usually it will be found impossible to shake him in his main conviction, that fully pedigreed stock, used for ordinary productive purposes under ordinary farm conditions, will not pay.

If there be any justification for this attitude—and it seems there is a good deal—it must follow either that pedigree breeders are aiming at something different from ordinary commercial usefulness, or else that the system of breeding which they follow is seriously at fault. Of course it is true that in the live stock economy of the country there is a place for breeds that do not possess all the qualities that go to make commercial usefulness. A breed like the Border Leicester, whose function is to provide crossing sires, must be judged not by its own commercial merits but by those of its crosses. The mutton of the Border Leicester is almost too fat to be eaten, yet the breed is a very valuable mutton breed. Again, if one wants a Shorthorn bull to cross with Galloway cows, in order to produce butchers' cattle, it is of no consequence that he belong to a prolific or a milky strain; size and thickness of flesh and early maturity are the only things that count. But obviously, in the case of the majority of our breeds, this one-sided sort of excellence is not enough. Even when the production of cross-breds is the ultimate object in view, as it is in most schemes of commercial meat production, it is essential that the foundation stock—the female side—should have a measure of all-round merit rather than super-excellence in one or two special qualities. Indeed it is probably true that here hardiness, prolificness and milking capacity are of more consequence than early maturity or quality of meat. In other cases, notably that of milk production, cross breeding is not a suitable method for producing commercial stock. In order that she may milk, a dairy cow must breed, and if she be a cross bred her progeny will, in a generation or so, be mongrels.

The bulk of our stock, if it is to be improved at all, must be improved by systematic grading, that is to say by the repeated use of males of high quality, all of the same breed. The most important function of pedigree breeders is to produce stock for this purpose, stock which under any reasonable test will show itself to be a real business proposition for the commercial farmer. And this is just what the pedigree breeders, on the whole, have conspicuously failed to do. They have effected marvellous improvements in certain respects; in other respects they have been content with a standard of merit that no plain farmer can tolerate. It is for example a self-evident proposition that a dairy cow cannot pay for her keep unless she produces a reasonable quantity of milk; yet it is well known that, when milk

records began to be demanded, many prize winning strains of dairy stock were found to be worse than indifferent milkers. Any commercial pig breeder knows that the thing that makes for profit, above all others, is the ability of the sows in a herd to produce large litters of thriving pigs; supposing that pig recording becomes standard practice, will it be found that our highly improved pedigree herds are those in which this characteristic is most markedly developed? Again, most people will agree that in mountain sheep the most important quality is ability to live, to survive periods of scant food and severe weather; what test of hardiness do our ram breeders apply when they house their sheep during winter and feed them on cabbages and cake?

A great part of the trouble arises because showyard standards and the showyard point of view have become an obsession with our pedigree breeders. The standard of points adopted in the judging of a particular breed or type of live stock is at the best a very partial and incomplete measure of real worth. If for example we set out to judge a class of beef cattle (which offer a relatively easy problem) we adopt, to some extent, the point of view of a butcher, and consider the value of the different animals per unit of live weight; we have a certain standard in mind about what constitutes an adequate size for a given age; we have certain more or less arbitrary notions about symmetry of form and about breed points, such as the set of the horns or the colour of the nose or the shape of the head; and having weighed up excellencies here against defects there we hand out the prize tickets. We know very well that our judgment, so far as it has been based on butchers' points, might easily prove to be wrong if the cattle were slaughtered and the carcases valued. In any case we have taken no account of the cost of production of the various animals because we have no data bearing on the question, and it may well be that, if the cattle were slaughtered and the carcases sold on the spot, the worst beast in the class would leave the largest profit (or the smallest loss) to the producer. We may indeed flatter ourselves that we know the marks of a "good doer"; but if we put ourselves to the test, if we grade a lot of store cattle on their appearance and then put them up for experimental feeding, we shall generally find that we have made but a sorry attempt at the business.

The showyard at its worst comes near to losing sight of commercial realities altogether. This is perhaps most likely to happen when a particular breed is taken up by moneyed men without the hope or the intention of financial gain. It is the custom to regard such men as benefactors to the farming community, and it is doubtless true that their intentions are generally of the best. But few of them are numbered among the great live stock improvers. Bakewell and Amos Cruickshank and Hugh Watson were not moneyed men and did not breed stock for their amusement.

Another evil of the showyard is its tendency to encourage grossly unnatural methods of feeding and management. It is

a truism that prizes are as often as not awarded to the best fitted rather than to the best animals. The art of "bringing out" stock —in plain language the art of disguising faults—has made more progress than the art of breeding. It is not merely that all this "bringing out" is a waste of skilled labour and good food. It happens in certain breeds that the most suitable raw material for showing is not the naturally good animal, but rather that which will respond to wholly unnatural treatment and whose faults are of the kind that can be disguised. A thick fleshy bull calf with a high tail head or a slack back is useless to the showing man, but an ill-thriving, thin-fleshed beast, if he has a good head and straight lines, possesses great possibilities. A small ram lamb from a mother with no milk—a lamb that would be a "shot" if he were a wether—may yet be just the one to be manufactured into a prize shearling.

It may be freely admitted that Shows have, in the past, done a great deal for the improvement of our stock; but it is seriously maintained that they have to a great extent outlived their usefulness. It is not suggested that all Shows be abolished. Probably their most whole-hearted critics would spare the big national Shows and the Annual Shows run by the Breed Societies. But the number might be greatly reduced with advantage. Prize winning might then cease to be regarded as an end in itself and showing might cease to be a business. Whether or not this can be effected, it is certain that some other and more efficient method must be devised for measuring the real merits of our stock. There is already a Pig Recording and Pig Testing scheme in being. There are Egg Laying trials and there are Milk Recording schemes, which with all their faults have proved of great value. It only remains to apply the same principle, the principle of a direct test of utility, to the other classes of stock.

RECLAMATION OF PEAT LAND IN NORTHERN EUROPE.

W. G. Ogg, M.A., B.Sc., Ph.D. (Cantab),

Edinburgh and East of Scotland College of Agriculture.

Vast areas of the land surface of northern Europe are covered with peat, and this peat covering varies greatly from place to place in thickness, composition, state of humification and moisture conditions.

Peat formation occurs when conditions are such that the decomposition of plant remains is inhibited or prevented, and it is by no means confined to cold and wet climates. Absence of air through water-logging, the presence of acidity, shortage or absence of nutrients necessary for the organisms which bring about decomposition, are conditions all of which favour the

formation of peat. These conditions are most frequently met with :—

1. Where the climate is humid and cool.
2. Where the soil is poor in bases owing to either the nature of the parent material or the leaching of these bases from the soil.
3. Where the land surface tends to be flat or has hollows without drainage.

In many places peat exists at the present time under conditions which do not appear favourable to peat formation. Such cases can often be explained by the different circumstances in earlier times. Probably the conditions during the period following the glacial epoch were extremely favourable to peat formation, and in many places the peat is now in process of decay.

Peat may vary in thickness from a fraction of an inch to 30 feet or more, and in degree of decomposition from practically unaltered plant remains to structureless colloidal material. In section, a peat deposit often shows various stages from black colloidal highly decomposed material at the bottom to brownish undecomposed plant remains and litter on the surface.

Peats vary greatly in composition, and this is largely due to differences in the nature and chemical composition of their constituent plants, and indirectly to the differences in composition of the water or soil in which the plants grew. The moisture condition of the peat depends especially on the nature of the underlying soil and on the climate.

Peat lands may be arranged in three main groups—heath, moor and fen. When typically developed these differ from each other very markedly, but intermediate forms occur which are sometimes difficult to place.

Heathland Peat.—The peat layer of heathland is thin—varying from a fraction of an inch in the south and south-east of England up to 8 or even 12 inches in certain parts of Scotland. The substratum is usually sandy or gravelly and the rainfall moderate. According to Tansley most of the German, Belgian and southern English heaths occur in regions with an annual rainfall between 25 and 40 inches, but the Cornish heaths and those of the eastern highlands of Scotland often have a rainfall of 40 to 60 inches. Typical heathland peat is rather a dry and usually strongly acid humus (German Trockentorf) and contains a considerable admixture of mineral matter, but the thicker peat of certain Scottish heaths is often wetter in character and consists of relatively pure humus.

The sandy substratum is impoverished in mineral salts through leaching, and the humus and iron compounds which are carried down frequently form a hard pan below the surface. The dominant plants in heathland are heather (*Calluna vulgaris*), other members of the Ericaceæ, lichens and mosses.

Moorland Peat.—The term moorland is employed in many Continental countries to denote all areas covered with more or less deep peat. In this country the term is restricted to the

areas of deep peat poor in bases, but in popular language it is often applied also to what ought properly to be termed heathland. Many of the Scottish so-called moors, for example, are really heaths.

Moorland peat ranges from less than a foot to over 30 feet in thickness. There are several varieties which differ considerably in character and composition, but they have in common the properties of strong acidity, low content of mineral salts and relatively high moisture content. The water concerned in the formation of moorland peat is usually rainwater or groundwater very poor in bases.

Moorland is sometimes divided into :—

A. Upland Moor—occurring on plateaux and hill sides in regions of high relative humidity.

B. Lowland Moor—not dependent on high rainfall, but developing where there is surface water or ground water poor in bases.

It is more satisfactory to sub-divide moorlands according to their plant associations.

The most important types found in this country are as follows [1] :—

1. *Bog Moss or Sphagnum Moors.*—The various species of bog moss are the chief constituents, and owing to the habit of growth of sphagnum, the clumps of vegetation in this type of moor are highest in the centre and slope towards the edges. This convex appearance of the surface led to the term "Hochmoor" being applied to such moorland in Germany, and the term has been translated into English as "High-moor." This, however, is rather misleading as it may convey the impression that such moors occur only at high altitudes, and Dr. W. G. Smith suggested "Hump moor" as a better English equivalent.

The term "Hochmoor" is often used in Germany for all the varieties included in this paper under the heading "Moorland." The sphagnum type of moor is much more common in certain Continental countries than in Britain.

2. *Cottongrass Moors.*—Species of cottongrass (especially *Eriophorum vaginatum*) are the dominant plants in this type of moor, which usually occurs on plateaux at considerable altitudes and is frequently deep and wet.

3. *Scirpus Moors.*—*Scirpus cæspitosus* is the dominant plant, but heather, cottongrass, bog moss, &c., are also found, and the peat is usually deep and water-logged. Moors of this type are abundant in the north-west of Scotland and in the Hebrides.

4. *Blaeberry Moors.*—The chief plant is the blaeberry (*Vaccinium Myrtillus*), but other plants such as the crowberry, heather, &c., also occur. The peat is usually of a drier nature than in the types of moor already mentioned and it is often comparatively shallow.

[1] Fuller descriptions are given by Lewis, Moss, and W. G. Smith in Tansley's *Types of British Vegetation*. (Cambridge, 1911.)

5. *Heather Moors.*—The most abundant plant is heather (*Calluna vulgaris*), and the peat of this type of moor is also of a rather dry and shallow character. It is usually from about 1 to 4 feet thick, and where shallow it contains a considerable admixture of siliceous mineral matter—merging imperceptibly into heathland peat.

6. *Grass Moors.*—This type has been described by W. G. Smith as intermediate in composition between the Scirpus moor and siliceous grassland. The vegetation is composed mainly of a variety of grasses, rushes and sedges, and the soil is peaty but richer in mineral constituents than the other moorland types, acid in reaction, and usually resting on an impervious subsoil at shallow depth.

Fenland Peat.—This term is applied to deep peat relatively rich in mineral salts and alkaline or slightly acid in reaction. Such material is usually formed along lakes, estuaries or river valleys where the water is rich in bases. Moor of this class has a flat or concave surface in contrast to the convex surface of Hochmoor, and has been termed " Flachmoor " by the Germans. The term " Niederungsmoor," also used in Germany, is probably a better equivalent for our fen, as Flachmoor may be poor in mineral salts.

The difference between fen and moorland peat is reflected in the marked difference in vegetation. As in the case of moorland, the fen vegetation is not everywhere the same, and sub-divisions can be made on this basis. Here it will be sufficient to distinguish two main groups—

A. Fen proper, in which sedges and grasses predominate.

B. Carr, in which the plant association consists largely of trees and shrubs.

Both groups are found in East Anglia and in smaller areas in other parts of the country.

Intermediate Types of Peat Land.—As might be expected there is no sharp line of distinction between moor and fen. Various intermediate forms occur and under certain conditions fen may pass into moor—the German " Uebergangsmoor."

The average differences in the chemical composition, and in the plant food content per acre in the surface layer, of the different types of peat are given by Professor Tacke as follows :—

TABLE I.

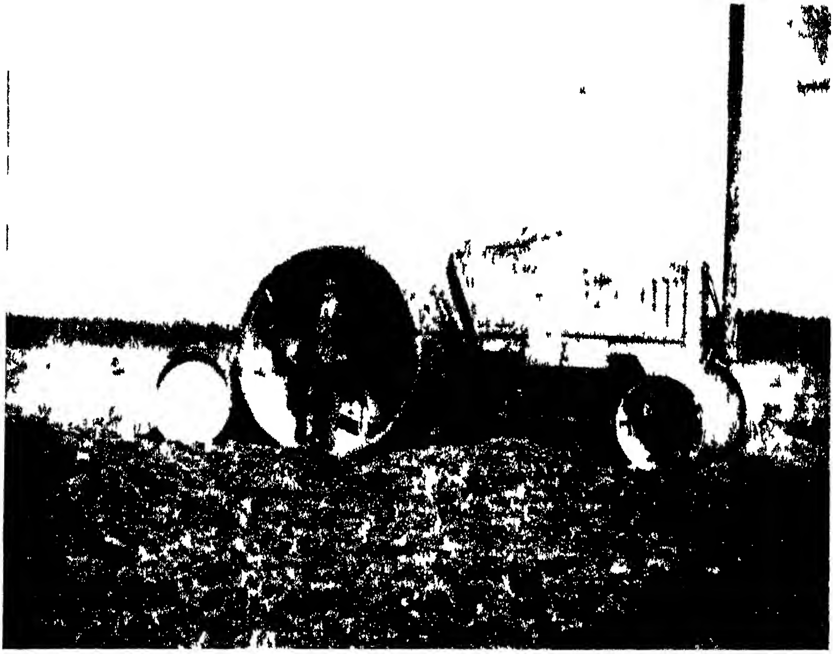
Percentage in dry matter.

Type.	Nitrogen.	Phosphoric Acid.	Potash.	Lime.
Fen peat	2·50	0·25	0·10	2·50
Intermediate forms ...	2·00	0·20	0·10	1·00
Moorland peat	1·20	0·10	0·05	0·35

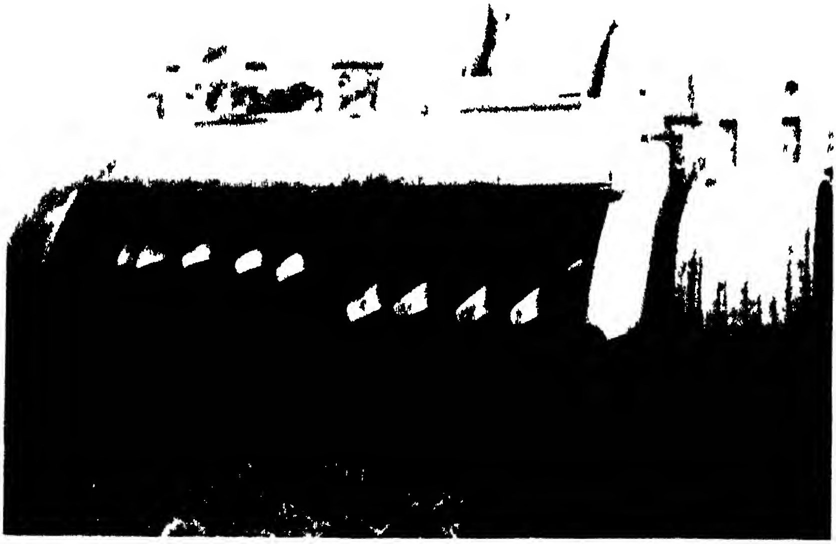
Near Linköping, Sweden. — The Experiment Station of Swedish Peat Society at Flahult.
Grain experiments and steading in distance.

Experiment Farm of Swedish Peat Society at Flahult.

The Highmoor in its original state.



Lanz fraise or motor cultivator, Gisselas, Sweden



Lanz fraise or motor cultivator, Gisselas, Sweden

Back view showing knives

TABLE II.

Lbs. per acre in the surface 8 inches.

Type.	Nitrogen.	Phosphoric Acid.	Potash.	Lime.
Fen peat	10,704	1,070	267	17,840
Intermediate forms ...	7,136	624	178	3,568
Moorland peat	2,676	223	89	713

The above figures show how enormous are the differences between the different types, and how necessary it is to take account of these differences in agricultural treatment. The fen peat is much richer than the moorland peat in nitrogen, phosphoric acid and potash, but the greatest difference is in lime content, where the one has 25 times as much as the other.

Utilisation of Peat Lands.

Possibilities of utilising the vast areas of peat have been considered in every country. Thoughts were no doubt first turned to the utilisation of the peat itself as fuel and also as litter. Cheap coal has greatly curtailed its use as fuel in recent years, but attempts are being made to overcome high labour and transport costs by mechanical methods of obtaining the peat instead of hand cutting, and by further drying and compressing into briquettes.

The utilisation of peat land for agriculture and forestry has also received attention from very early times. In this connection the different varieties of peat already described must be taken into account. That the early cultivators discovered that peat was not all alike is evident from the fact that in this country most of the fenland peat has been cultivated for many years, whereas the greater part of the moorland and heath is still in its wild state and practically waste land.

Fenland peat, as was evident from Tables I and II, is much richer in plant nutrients and especially in lime than the other types, and in some cases only draining is necessary to enable satisfactory crops to be grown for a time on this class of land.

With moorland and heath, however, the difficulties are much greater, and although considerable areas of our present cultivated land were undoubtedly at one time heath or moor, they have only gradually been brought to their present condition by years of patient cultivation and improvement. Reclamation of such land on these lines is impossible at the present day, as it would involve a long period of totally unremunerative cultivation.

Increased knowledge of the properties and requirements of the different kinds of peat, the advent of artificial manures and improvements in cultivation machinery have, however, opened up fresh possibilities. Here and there experiments have been tried on our moorland peats by more modern methods, but no extensive work has been carried through and no organisation

exists to study and encourage the agricultural development of peatland.

In other countries it is very different. Most of the northern and some of the central European countries have for many years made a scientific study of moor cultivation and are gradually reducing their areas of waste land. Some of this work has been carried out by the governments of the various countries, some by agricultural and forestry schools, and a very important part of it by moor cultivation societies. Certain communities have also carried out reclamation work, and a great deal has been done by private individuals.

Examples of State Reclamation Work.—In every country where such work is going on, the State takes part in it indirectly by making grants to the peat societies and colleges. In some countries it has taken a direct part, and, as examples, a brief account will be given of some of the peatland activities of the German and Danish governments.

North-west Prussia.—In 1876 the Central Moor Commission was set up to act as technical adviser to the Prussian Ministry of Agriculture, and at its instigation an experimental station was established at Bremen to study the cultivation of moorland, of which well over two million acres still remain uncultivated in Prussia. The valuable work carried out at this station has had a very beneficial effect not only in Germany but in many other countries. In addition to the large and well equipped laboratories in Bremen there are one or two sub-stations, several experimental farms and many demonstration areas, where methods of draining, cultivation, manuring and cropping are studied.

The practical outcome of this scientific work has been the cultivation of large areas of waste moorland, much of it Hochmoor, in north-west Prussia. Examples of reclamation successfully carried out during the past few years may be seen at Wiesmoor, Konigsmoor, Dortmund, and other places in that neighbourhood. Some of the work is carried out by convicts, and during the war prisoners were also employed on it. A good description of the reclamation of Ostenholzer Moor, Hanover (Royal Prussian lands), has been given by Mr. G. B. Farlam,[1] who as a prisoner of war was engaged on this work for three years.

The work at Stadtgut Dortmund, near Oldenburg, was commenced in 1919. Up to the present 1250 acres have been cultivated at a cost of about £24 per acre, and the results obtained are highly satisfactory.

Bavaria.—In Bavaria, where the area of moorland is about 350,000 acres, a State institute for moor cultivation was established in 1900 at Munich, and a moor cultivation commission was also appointed by the Ministry of the Interior. The purpose of the State institute is to develop moor cultivation and to give advice to farmers on moorland problems. It has now numerous experimental stations and demonstration areas, and during its

[1] *Journal of the Board of Agriculture*, 26, 691 (1919).

28 years' existence has reclaimed over 25,000 acres of waste land. The farm at Bernau is an excellent example of what can be done in the way of successfully cultivating acid peat land, and a recent achievement is the farm at Weitmoos, where over 300 acres of moor have been reclaimed and are now highly productive.

The scientific work of the Bavarian Institute is also well known.

Denmark.—An interesting example of State reclamation work is going on at the present time in Denmark. During the war-time shortage of fuel the Government appointed a commission to look into the development of the country's peat resources. This commission decided that when the peat for fuel was removed, the surface layer should be replaced on the underlying ground and cultivation carried out on the system which is adopted in Holland. At the end of the war, when coal had again become plentiful and there was much less demand for peat fuel, the government commission recommended that the agricultural development of moorland should be continued without removal of the peat.

The result of the proposal is a project for the reclamation of the Vildmose, a large area of sour peat land in the neighbourhood of Aalborg in Jutland. In 1921, 7000 acres of this bog were purchased by the government, and the work is being carried out under the direction of a small Peat Reclamation Committee of which a former Minister for Agriculture is chairman. Already about 3,000 acres have been successfully brought into cultivation at a cost of £29 per acre, of which £5, 10*s*. per acre represents the cost of the land. The land is laid down in pasture and is rented out to farmers for grazing. Some of the cattle come from a considerable distance, and for an inclusive charge of about £2, 8*s*. per acre the land is manured, fences and drains kept in order, and the cattle watered and tended for the season.

It is intended that the land will be sold eventually, but it is considered very desirable to have control of the manuring and stocking of such land for the first few years.

The Work of Agricultural and Forestry Schools.—In every country where there are extensive areas of peat land, the cultivation and treatment of such land naturally form a part of the activities of the agricultural and forestry colleges.

The peat land experiments being carried out at the Norwegian Agricultural College at Aas may be taken as an example. There is an area of bog moss adjoining the College, and part of this was brought into cultivation 50 years ago and forms excellent permanent pasture. Experiments on an adjoining area of the uncultivated bog were laid down a few years ago. The land is fairly deep sphagnum peat with a very acid reaction, and the natural vegetation is largely heather. The heather was burnt off, but the raw surface layer was not removed before cultivation. Various dressings of lime, phosphates, potash and nitrogen were applied and the effects of these on pasture are being studied. In

addition to the field work, laboratory and pot culture work are going on.

A good example of the scientific study of peat land for forestry purposes is the work of the Swedish Institute for Experimental Forestry. In the well-equipped laboratories at Stockholm, the study of humus and questions of nitrification form an important part of the work. There are also four experimental forests, and a very fine study of the soils and vegetation of two of these (Kulbäcksliden and Svartberget in northern Sweden) has been carried out. These areas include large stretches of peat bog, and at the present time a part of the great sphagnum bog (the Flakayalsmyren) is being drained for experimental work.

Moor Cultivation Societies.—One of the features almost invariably associated with the utilisation of peat land abroad has been the formation of moorland and heathland cultivation societies. Probably the oldest is the Danish Heath Society formed in 1862, and this was followed by the formation of similar bodies in Germany (1883), Sweden (1886), Holland (1888), Finland (1894), Austria (1900), and Norway (1903). These societies differ from one another considerably in constitution and function, but they have much in common. They are voluntarily organised bodies formed for the purpose of encouraging the reclamation of waste land. In some cases the utilisation of peat for litter and fuel is also studied, and some of the societies deal with forestry as well as agriculture. The members pay a small subscription, and the remainder of the money is obtained in the form of grants from the government, agricultural societies, "county councils" and private individuals. The societies have as a rule a central laboratory, a pot culture station, an experimental farm or farms and demonstration plots. The functions of the societies are as follows :—

1. To ascertain the extent and nature of the peat land of the various countries.
2. To study chemically, bacteriologically and botanically the various types of peat.
3. To study the agricultural and forestry possibilities by means of pot culture and field experiments.
4. To disseminate information regarding the work by means of publications, lectures, and demonstration plots.
5. To give advice and assistance to farmers regarding the cultivation and improvement of peat land. This help often takes the form of arranging loans, lending or hiring the expensive peat cultivation machinery, and obtaining lime or marl at favourable rates.

During the last 70 years the area of uncultivated land in Jutland—largely heath—has been reduced by more than half, and in this work the Danish Heath Society has played a very important part. The society has its headquarters and laboratories at Viborg, and a staff of about 100, a large number of whom are agricultural graduates. Much attention is devoted to affores-

tation and the provision of shelter belts as well as to agriculture. One of the most notable achievements of the society has been the organisation, in conjunction with the government, of a cheap supply of marl. A survey was made of the marl deposits and light transportable rails laid down to facilitate transport.

The Swedish Peat Society was founded 43 years ago by Carl von Feilitzen, and from small beginnings has developed into a very well-equipped organisation with the following staff:—director, botanist, two chemists, assistant at the experimental garden, three consulting engineers, a superintendent at the experimental farm at Gisselås, and a manager at the farm at Flahult. There are excellent laboratories with library and museum, a pot culture station and an experimental garden at the headquarters of the society at Jönköping, which is over 100 miles further north than Edinburgh. A few miles away at Flahult a farm was established in 1890 on 272 acres of moorland, and of this 180 acres consist of acid moor (Sphagnum type) having an average depth of 10 feet. Results of great value have already been obtained from this farm, and crops are grown which compare favourably with those on farms with good mineral soil.

In 1920 the society purchased 250 acres of land of the fen or carr type at Gisselås, over 300 miles further north than Kirkwall. In spite of the rigorous climate excellent results have been obtained, and it is difficult to realise that eight years ago the farm was an area of waste land. The cost of this reclamation work in 1921-1922, when prices were considerably higher than they are at present, was estimated at £21, 5*s*. per acre. The annual grants which this society receives have increased from £800 in 1890 to over £5,500 at the present time.

Reclamation by Communities and by Private Individuals.—Examples of private reclamation work are to be found in Jutland. Near Viborg considerable areas have been brought into cultivation recently at a cost of £11 to £12 per acre, but it was not necessary in these cases to have the drains very close together. Since reclamation by individuals was often unsatisfactory because of patches left unreclaimed, the plan now usually followed is for the owners of a piece of moorland to form an association to carry out the work as a whole. The association appoints a committee of four or five members who take out a loan and arrange with the Danish Heath Society for the hire of a moor cultivator and for a supply of marl. The moor cultivator, which is a very expensive implement, is hired out at about £1, 10*s*. per acre, and this includes driver and petrol.

Similar projects are going on at Rhinluch, a stretch of over 30,000 acres of fen land near Berlin. Main drains have been constructed for the whole area with the aid of government funds by the Rhinluch Melioration Genossenschaft, which also sees to their upkeep. This fen belongs to private individuals, and when half the farmers of any area decide they wish to reclaim their portion they form an association, which the others can be compelled to join. The government gives grants and loans to the

association, which carries out the secondary draining, hires a moor cultivator and generally administers the reclamation. One farmer stated that he purchased an area of this fen (uncultivated) at £12 per acre; cultivation by the association cost £11 to £12 per acre—making a total cost of £23 to £24 per acre without buildings.

In Holland, the town of Assen during a period of unemployment utilised the services of the unemployed in reclaiming a stretch of peat land, and the community of Deurne in Brabant, which owns large areas of moorland, has developed its peat resources in a most enterprising fashion by utilising the fuel, manufacturing moss litter and cultivating the land.

Details of Agricultural Development.

Type of Peat.—In any scheme of reclamation, it is particularly important to ascertain first of all to which of the three broad groups—fen, moor or heath—the peat belongs. More exact information as to the type of peat and data on the chemical and botanical composition are very desirable.

Fen peat is frequently black and nearly structureless. It is rich in calcium and nitrogen, and contains a fair amount of the other substances required by agricultural plants. The chief necessities in this class of land are efficient drainage—which in turn brings about aeration and nitrification—and, for most crops, additional phosphate and potash.

Moorland peat varies a great deal in colour and structure, but frequently has a spongy and more or less undecomposed surface layer. Its drawbacks are wetness (with its associated lack of aeration and nitrification, and high acidity) with its associated poverty in lime, potash and phosphate.

Systems of Reclamation.[1]

1. *Removal of the Peat followed by*—

(a) *Cultivation of the skinned land.*—This is not extensively practised on account of the very poor nature of the material below the peat. After a period of cultivation and liberal manuring it may become fairly fertile.

(b) *Warping.*—The land is systematically flooded with mud-bearing water until a sufficiently thick deposit of this rich material is obtained. This is practised extensively in Holland and to some extent in the east of England.

(c) *Deposition of refuse.*—In the neighbourhood of large cities, reclamation of limited areas may be combined in this way with the disposal of city refuse.

(d) *Dutch "Dalgrond" System.*—This is a very satisfactory system where there is an outlet for peat fuel, and it is practised extensively in Holland, where there is a law to the effect that, when peat is removed, the surface 24 inches shall be laid aside and replaced on the underground material. This is mixed with

[1] See also E. J. Russell, *Journal of the Board of Agriculture*, 27, 1104, and 28, 32.

sand from the subsoil and the so-called "dalgrond" is cultivated.

2. *Cultivation of the Surface of the Peat.*

(a) *After burning.*—The moor is drained and when the surface is sufficiently dry it is burnt. Crops such as buckwheat, rye and oats can be grown successfully for a few years. When the yields begin to decline, it can be burnt again, but after several years of this treatment the soil is said to become almost unproductive. This method was practised in Holland a good deal at one time and also in Germany, but it is not favoured at the present day.

(b) *After heavy dunging, sanding or claying of the surface.*—Efficient drainage is, of course, the first essential. The effect of applying farmyard manure is to supply plant food, improve the texture, and promote bacterial activity.

The application of a dressing of sand (about 4 to 6 inches in depth) to the surface has been extensively practised in Germany and elsewhere since Rimpau carried out his successful experiments many years ago. The sand makes cultivation easier and has a beneficial effect on texture, moisture content and temperature. This method has not been used to the same extent in recent years on account of the expense involved. Where sand is not available in close proximity to the reclamation work, the cost is quite prohibitive.

Claying of peat soils is a very old practice, but like sanding is rather expensive at the present day. It is practised to some extent in Finland, where it has been found possible by this means to reduce the dressing of lime necessary.

(c) *By means of special cultivation machinery, followed by dressings of manures.*—Modern developments in cultivation machinery, such as the cultivation motor (German—Fräse), the use of heavy rollers, and the increase of knowledge regarding the use of lime and artificial manures have brought about great changes in the system of moor cultivation. At the present day the general practice in most Continental countries (except where the peat is used extensively for fuel) is to drain the land, cultivate the raw surface by means of a moor-cultivator, and apply lime and fertilisers as required.

Details of Reclamation.

Draining.—The details of draining depend on such factors as thickness of the peat, the nature of the underlying material (where the peat is thin), the configuration of the land, the nature and degree of decomposition of the peat, and the climate (especially rainfall).

(1) *Deep Peat.*—Peat frequently contains about 90 per cent. of water, of which part is held mechanically and part chemically. In raw undecomposed peat, much of the water is mechanically retained, whereas in black humified peat the bulk of the water is chemically bound in the colloids. Mechanically held water is comparatively easy to get rid of by drainage, but the water held in the colloids is extremely

difficult to remove. In many peat deposits there is a surface layer of more or less raw undecomposed material, and where this is present the drainage problem is much easier than where the peat is highly colloidal right to the surface.

Draining is usually carried out by means of a series of main drains about 100 yards apart and 5 to 7 feet deep, and a series of secondary drains which range from about 13 to 32 yards apart and are 3 feet 6 inches to 4 feet 6 inches deep. The distance apart varies according to local conditions —a common distance being 21 yards. In some cases, several secondary drains run into a collecting drain before going into the main ditch. Formerly it was customary to leave all the drains open, but now it is the general practice to cover the side drains and sometimes also the main drains. Precautions must, of course, be taken to prevent the reclaimed area from being flooded by water from adjoining unreclaimed land. The channel of the closed drain may be kept open by heather or brushwood or by turfs. Such drains are relatively cheap and are said to last for a considerable period, but at the present time they are usually made of timber or of clay tiles. The timber drains consist of four planks nailed together giving a channel with a cross section of about 3 by 4 inches. By means of wedges, a slit is left to allow the water to enter. Where tiles are used it is desirable to lay them on a foundation of heather or timber to prevent displacement.

Where the peat is very soft the sides of the trenches may collapse if they are dug to their full depth at one operation. To overcome this difficulty, they are often left for a year partially dug to allow the sides to harden, and the excavation is completed just before the tiles are laid. Drainage of deep peat is expensive because of the amount of hand labour it involves. The bogs as a rule are too soft to permit of mechanical drainers, but the use of explosives has been suggested.

(2) *Shallow Peat.*—Heathland may suffer from drought instead of lack of drainage, and in that case an irrigation rather than a drainage system is required.

In cases where peat has been removed, and the surface layer replaced on the mineral soil (Dalgrond system), the scheme of drainage depends on the nature of the sub-soil, since the replaced layer is only about 20-24 inches thick. In Holland, where the underground material is frequently sand, a very simple system of draining by means of ditches about 100 yards apart is sufficient.

In peat land there is also a risk of overdraining, and arrangements should be made by which the drainage system can be dammed up in the dry season.

Cultivation.—After draining, the surface litter is collected and burnt. Where horses are used in cultivation they are usually

shod with wide wooden shoes to prevent them from sinking. Steam ploughs and tractors—sometimes with caterpillar wheels—are also used. Recently a very useful machine, named the Fräse in Germany, has been devised for the first cultivation of peat soils. It is a motor-driven machine like a tractor with wide wheels, and an attachment behind containing a long shaft with knives or tines. When this is put into gear it revolves at a rapid rate and is then lowered to the surface of the peat, which is churned into small pieces. It is usual to cultivate twice with this machine, first to a depth of 8 inches and the second time to a depth of about 15 inches. The surface of the peat is thoroughly broken up and aerated at a much less cost than by any other means, and one machine can cultivate from 8 to 12 acres (single cultivation) per day.

The regular use of these machines for subsequent tillage is not advisable, since they are apt to allow the land to become infested with weeds and they produce too fine a tilth—making the surface impermeable to rain water. Where the peat is shallow and stones are liable to be encountered, or where tree stumps or roots occur abundantly, it is often impossible to use the moor cultivator, and in such cases a 3-furrow plough drawn by tractor is often used.

Another important operation in the cultivation of peat land is rolling by means of a heavy roller. This should weigh at least a ton per yard of width, and its use is quite essential for successful moor cultivation, especially for pasture land. The moor cultivator is often employed to draw the roller and other machinery.

Liming.—The fen type of peat usually contains an ample supply of calcium and does not require liming, at anyrate until it has been cultivated for a good many years.

For moor and heath land lime is necessary. The calcium may be applied as shell sand, ground limestone or burnt lime. In countries like Denmark, where there are abundant marl deposits, marl is used as a rule. In many places ground limestone is used, but where it has to be transported long distances it may be cheaper to substitute burnt lime. It has been found in practice that moderate dressings are best. If dressings sufficient to neutralise the acidity are applied, plant growth is retarded and diseases are liable to appear.

For pasture land a dressing of 30 to 40 cwt. of burnt lime per acre (at the time the land is reclaimed) has usually been found to be sufficient, and for arable land about half the amount—or roughly double these quantities of ground limestone. These dressings are sufficient for a number of years, especially if calcareous manures are applied. The moorland cultivator can be employed to mix the lime in the surface layer, and this should be done several months previous to cropping.

Manuring.—(1) *Phosphoric Acid.*—Practically all peat land is poor in phosphoric acid, and the moor type is even poorer

than the fen. The manurial dressings required depend largely on the crops, but for the first few years it is usual to apply 1 to 1¾ cwt. P_2O_5[1] per acre per annum in order to enrich the soil. Afterwards the dressing is decreased to about ½ to 1 cwt. The form in which the phosphoric acid is applied also differs according to circumstances. For fen soils superphosphate has usually been found best, and for moorland soils basic slag or ground mineral phosphates give good results. These must be finely ground and applied early in the year.

(2) *Potash.*—Peat soils are very poor in potash and heavy dressings of potash fertilisers are necessary. The amount used again varies according to the crop, but for the first year or two of cultivation 1¼ to 1¾ cwt. K_2O[2] per acre should be applied, and this can be decreased later to about ½ to 1½ cwt. according to the crop. It is usual to apply it as muriate or sulphate of potash or as potash manure salt, but kainit has been found to give very satisfactory results with cereal crops in some places. Application early in the season is desirable.

(3) *Nitrogen.*—Fen soils are usually rich in nitrogen, and may not require much additional nitrogen for many years. It is frequently desirable, however, to give them a small dressing of nitrogenous manure for the first year or so until bacterial activity is ensured.

On the other hand, with moor soils fairly heavy dressings of nitrogenous fertilisers are advisable. For the first year or two ½ cwt. of nitrogen[3] per acre (usually as sulphate of ammonia, nitrate of soda or nitrate of lime) is quite a usual dressing, and this may be reduced later—the amount again depending on crop and other factors.

(4) *Farmyard Manure.*—The use of farmyard manure is very beneficial, especially on moor soils. In addition to supplying plant food, it promotes bacterial activity in the peat. Heavy and frequent dressings with farmyard manure, however, tend to lodge the crops, especially on fen soils, and where dung is available it is the practice to apply it and artificial manures in alternate years.

Cropping.—The system of cropping must necessarily depend on climate, nature of the peat and the situation of the farm. In northerly districts where it is difficult to ripen cereals and to grow potatoes, much of the land is laid down in grass, but when cereals are grown they are cut green and dried for fodder. Timothy meadows are also common. In most places, however, the following crops can be grown on moorland soils :—oats, rye, potatoes, 6-rowed barley, turnips, and various legumes and grasses.

In certain cases the land is laid down straight away in pasture, but in most cases it is cropped—usually with potatoes and oats for periods of from two to five years before laying down in grass.

[1] 7–12½ cwt. basic slag (14 per cent. P_2O_5). [2] 2½–3½ cwt. muriate of potash.
[3] 2½ cwt. sulphate of ammonia.

This allows the land to be cleaned and assists in promoting oxidation and bacterial activity. Having been laid down in pasture, it is allowed to remain for five to ten years or even longer. Excellent pasture 30 years old was seen on moor peat in Sweden.

The following are two of the typical grass seed mixtures :—

Constituents.	Sweden (Jonkoping).	N W. Prussia (Dortmund).
	Lbs. per acre.	Lbs per acre.
Smooth stalked meadow grass	12¼	10½
Timothy	9	3½
Meadow Fescue	3¼	5¼
Foxtail	4½	. .
Ryegrass (perennial)	...	8
White clover	4½	8
	33½	35¼

One of the principal lines of research at the peat experimental stations is the selection of varieties suitable for peat soils. Much of the peat land of the moor type lies at a considerable altitude, and in northerly districts is apt to suffer from frosts. Hence it is important to obtain hardy and early-ripening varieties. Another point is the high degree of acidity of moorland and heath soils, and it is desirable to select varieties adapted to withstand high acidity. A tendency to weakness of the straw is one of the troubles with cereal crops grown on peat soils, and selection is being carried on with a view to overcoming that difficulty.

When leguminous crops are being grown for the first time it may be necessary either to inoculate the peat with soil from a field where legumes have been grown, or to inoculate the seed with cultures of appropriate bacteria.

Diseases of Crops on Peat Soil.—Cereals and grasses grown on peat soil appear to be liable to certain diseases (probably mainly physiological). Some of the diseases appear to be produced by over-liming, but in other cases they occur on very acid peat. The symptoms of these diseases are usually to be found in the leaves, which wilt or show whiteness at the tip. Manganese sulphate, copper sulphate, ammonium sulphate and farmyard manure have all been found useful in the treatment of one or other of these conditions.

Cost.—The possibility of the reclamation of peat land must ultimately come to be a question of cost. The introduction of the moor cultivator (German—Fräse) has done something towards improving the methods of cultivation and lowering the cost, and the introduction of artificial manures has made it possible to supply conveniently the substances in which peat soils are so deficient. There still remains the problem of drainage, which is one of the most expensive items, especially where labour is dear.

The total cost of bringing uncultivated peat land under cultivation on the Continent at the present time ranges from about £13

to £25 per acre. These figures include the cost of fencing and seeding, but labour costs in some of the Continental countries are much lower than in Britain.

A detailed cost for work carried out in Sweden [1] is as follows:—

	£ per acre.
Open draining	2·34
Covered draining	2·39
Removing roots	4·15
Collecting roots	·14
Removing sphagnum	2·00
Burning roots, mosses, &c.	1·60
Altering course of small stream	·62
Carrying away soil from drains, making roads and bridges	3·29
Cultivation by moor cultivator	3·51
Levelling fields	·43
Harrowing, rolling and seeding	·80
	21·27

The above cost was for an area of the fen type and was carried out in 1921-22, when labour costs were considerably higher in Sweden than they are at present.

From what has been accomplished on the Continent, it would appear that much of the peat land in Scotland could be reclaimed, but since most of it is of the moorland and heath types and strongly acid, liming and heavy dressings of artificial manures would be necessary.

The rainfall is heavy—in many places about 50 per cent. greater than in most of the cultivated peat areas on the Continent—and this would make drainage rather more expensive than on the Continent. The difficulty of harvesting crops in areas of such high rainfall, especially since the autumns are usually wet, makes cereal growing precarious, but the moist climate should be suitable for pastures.

The cost of carrying out such work on modern lines in this country has yet to be determined. Although the cost of reclaiming small patches would be prohibitive at the present day, it seems possible that with modern methods and machinery larger areas might be brought into cultivation or improved for pasture land at a moderate figure. An opportunity to study the whole problem has been afforded by Mr. T. B. Macaulay of Montreal, who has generously offered to provide a demonstration farm on moorland in the Island of Lewis, and at whose instigation the above information was collected.

[1] M. Stenberg, *Svenska Mosskulturforeningens Tidskrift*, 3 (1923).

A HYDRO-ELECTRIC FARM INSTALLATION.

M. E. HALDANE, B.A.

THE problem of rural electrification is at present attracting a large amount of interest. As very little experience gained in this country is as yet available, it is important to record any practical results, however limited, that have been obtained, particularly as regards the use of electric power for agricultural purposes.

The following paper describes a small hydro-electric scheme in Scotland which has been employed for both domestic and agricultural purposes during the last three years.

In this scheme water power is used, but there is little doubt that where a public supply is available at a moderate cost the conclusions as to the value of electric power would be equally true. The price, however, from an electric supply company might be higher, but on the other hand the supply given would be more reliable and less limited.

The water used for the hydro-electric power plant had for some years previously been used for the lighting requirements of Cloan House. A small reservoir on the burn running down the glen between Cloan and Foswell gathers water during the day and feeds a pipe line leading to the turbine house, which is about half a mile further down the burn and practically directly below the house. This gives a fall of approximately 120 feet. Sufficient power is generated for lighting Cloan and three small estate houses, and when lighting is not required the turbine is used to drive a sawmill. During the winter, when there is a large supply of water, several small radiators can be used. This plant was installed in 1904, and is thus rather out of date and somewhat wasteful; it is, however, still in regular operation and is a good example of the long life of water power plant. With the introduction of metal filament lamps a certain amount of spare current was available, and this was utilised by carrying a light copper wire from Cloan to Foswell House, a distance of nearly three-quarters of a mile. After a time this was found insufficient for the increasing demands of Foswell, so it was determined in 1925 to provide a separate supply for Foswell by using the fall in the burn above the Cloan reservoir.

The Cloan burn comes down a fairly steep glen and is joined about half way down by a smaller stream, the Foswell burn. In order to use all the water available and to get the necessary fall, an open ditch was carried along the side of the glen to take the water from the main burn at a place near the head of the glen. The Foswell burn was then diverted slightly to join the open ditch about 100 yards before the water enters the 8-inch pipe which carries it down to the turbine house in the glen below. This gives a fall of approximately 215 feet, and as the turbine

house is just above the Cloan reservoir, it allows the water to be used again for the lower turbine.

The open ditch is approximately 1,000 yards in length and is covered with wire netting, partly to prevent leaves, &c. blowing into the ditch, and partly to help to prevent snow drifting in and blocking the ditch in stormy weather. During the first winter snow caused some trouble by blocking the water in the ditch, but last winter, thanks to the netting, less trouble was experienced. In one or two places the water has to be carried over dips in the ground. This has been successfully accomplished by using corrugated iron sheeting, bent to a semi-circle and held in that position by cross bars, the whole resting on wooden trestles. (Fig. 1). At the point where the Foswell burn water joins the ditch an overflow trough is provided which protects the side of the ditch from being washed out in case more water comes along the ditch than the pipe can carry. (Fig. 2.)

The pipe line of about 450 yards composed of 8-inch steel pipes is carried over rough and very steep ground in places. At these points a few concrete anchors help to keep the pipes in position, while in one place brick pillars support the line where it crosses the bed of the Foswell burn. The turbine house is of brick with a concrete floor and corrugated iron roof with a roof light. The turbine is a Gilkes Turgo Impulse Turbine, driving direct a 17 K.W. 250 volt dynamo. In the turbine house there is a switchboard with ammeter, voltmeter, voltage regulator and two 100 amps. fuses, and in addition a killowatt-hour meter which registers the total amount of energy consumed. (Fig. 3.)

Heavy insulated cables take the current from the switchboard to the overhead aluminium stranded wires (7/·144) which carry it from the dynamo house to Foswell House, a distance of about 350 yards, and beyond to the two farms also supplied. Aluminium wire was used as it was slightly cheaper than copper wire at the time of installation, and because it is lighter and easier to handle. During the three years it has been in use the wire has proved perfectly satisfactory and shows no sign of corrosion. All the overhead wiring was done by estate labour, and discarded telegraph poles were bought for the purpose from the railway company. The insulators used are of the swan-necked type. Near the house a somewhat lighter aluminium wire branches off to the Home Farm, a few hundred yards from the house, and this continues to the other farm, Woodside, which is about half a mile further on. The wires are, of course, taken along the sides of the fields, and this slightly increases the distance.

At Foswell House the aluminium wires terminate on insulators attached to the wall of the house, and heavy insulated cables clamped on to these aluminium wires carry the power direct into the house to the main fuse board. The latter consists of a double-poled 60 amps. combined switch and fuse, an ammeter and voltmeter, heating and lighting distribution and fuse boxes.

The cooking and water heating of the house are both done by

electric power. The cooker consists of a four hot-plate stove with oven attached and a plug for an electric kettle. The total loading is 7,900 W.[1] The water heating is done by four 2 K.W. immersion heaters in a 100 gallon tank. Seldom more than two heaters are left on simultaneously, and most of the water heating is done during the night when comparatively little current is being consumed elsewhere.

There are also about twelve power plugs in the house, and some radiators are left on at night during the winter to heat the house. In addition the current is used for a washing machine, irons, toaster, coffeepot, vaccuum cleaner, fan, &c. Most of the radiators on the heating wiring use 2-3 K.W., and the smaller ones for use on the lighting wiring 250-600 W.

The garage at the back of the house has, in addition to lighting, a battery charging board and a plug for a small radiator, which is frequently used during the winter. The chauffeur's house is lit, as is also the gardener's, which is situated half way between the farm and Foswell House. A light branch wire is taken from the heavy overhead cable which passes at the back of the gardener's house, and small fuses in the house protect the main turbine house fuses.

At the farm heavy insulated cable is again clamped to the aluminium wire which carries the current to the switchboard, where lighting fuses control the lighting of the steading, the three farm workers' houses and the bothy for two single men. One large pair of fuses is used for the power required to drive a 24-inch feed threshing mill, bruiser and sawmill. When running full the threshing mill uses approximately 4 K.W. and the bruiser 2 K.W., while the sawmill varies very considerably with the weight of wood being cut, wood up to 12-inch diameter only being dealt with at that sawmill. The farm workers agree that the threshing is done more efficiently and swiftly with electric current than with the oil engine previously employed, as the drive is much steadier. The electric motor has also the great advantage of being very easily started up as compared with the oil engine.

The Home Farm is mainly a hill farm for breeding stock, but grows about 24 acres of oats every year, and the mill there does all the threshing of the crop. Practically all the grain produced from the 24 acres is used on the farm, and only the small quantity fed to the poultry is used unbruised, so that most of the oats go through the electrically-driven bruiser.

The power at the farm is also used for churning for home consumption. The ordinary 4-gallon barrel churn previously used was slightly altered to make it suitable for driving from a small one-sixth h.p. motor which is plugged into a lamp holder. By using some discarded pram wheels and a short bit of shafting the speed of the motor, which is 1,650 r.p.m., was geared down to the necessary 55 r.p.m. This shows how easily electric power can be adapted to suit farm equipment already in use.

[1] 1,000 W. = K.W. = 1⅓ h.p.

The total consumption of the farm is approximately 1,000 units per annum; this total does not include the brooders and chicken houses, which are heated in spring and form a considerable additional load. These are placed either in the stackyard or in one of the fields near the steading. A light insulated wire is taken from the main overhead cable to a small fuse board and thence to the brooders, where a small 250 W. radiator or carbon lamps are used according to the heat required. After the chickens leave the brooder they are placed in a larger chicken house and for the first week or so require some heat. This is supplied by a 600 W. hot air radiator carefully protected by netting. As the chickens get older this radiator is on at night only. Some difficulty is experienced in keeping the brooder at the correct temperature because of the variations in the outside temperature. This could be overcome by using a thermostat, but at present the temperature has to be regulated by ventilators or by changing from a radiator to carbon lamps.

At the other farm, Woodside, the amount of power used is rather less, as there is no sawmill, and the threshing is done by an 18-inch feed mill. The bruiser for oats is similar to the one in use at the Home Farm. Owing to a slight drop in voltage between the turbine house and Woodside,—the furthest point on the overhead line—the motor is a 225 volts 5 h.p. machine and drives direct on to the mill pulley, though for the bruiser a short piece of shafting is necessary to adjust the speed.

Various readings of the amount of current required for threshing have been taken at Woodside, as it is possible there to weigh the cartloads of unthreshed straw taken in. These work out at practically 0·2 units per cwt. of unthreshed straw or 4 units per ton. For bruising, the amount used is 1 unit per cwt. of oats, though a slightly smaller amount of current would be required for a large quantity of oats, as these measurements were taken when bruising only 2-3 cwt. at a time.

The number of units used at this farm from the middle of September to the middle of May is 188 for bruising and threshing alone. It is a small farm, and the oats from about 18 acres are threshed every year. In addition to this work the whole steading, two small houses and a bothy are supplied with light. During the last two winters an ultra-violet ray lamp has been run for one to one and a half hours per day in one of the cattle courts for experimental purposes, and this used about 500 W.

A chicken house is also heated from the overhead wires in one of the fields, but this is not included in the meter reading at the steading. Here, as at the Home Farm, a hot air 600 W. radiator is used and gives very successful results—the birds growing rapidly.

If the total possible load is on at the same time it is, of course, more than the dynamo can generate, but in practice this seldom happens, and the fact that the farms and the house are linked up by small field telephones helps to minimise the risk of any overload of this sort; before starting to thresh or bruise, a telephone

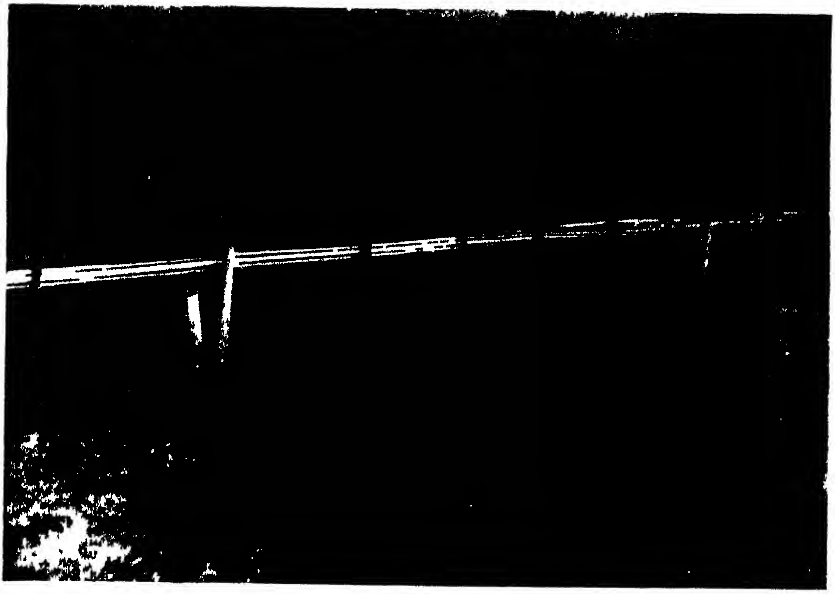


FIG. 1

Method of carrying open ditch over dips in the ground

FIG. 2

Point where Foswell Burn water joins open ditch, showing overflow trough.

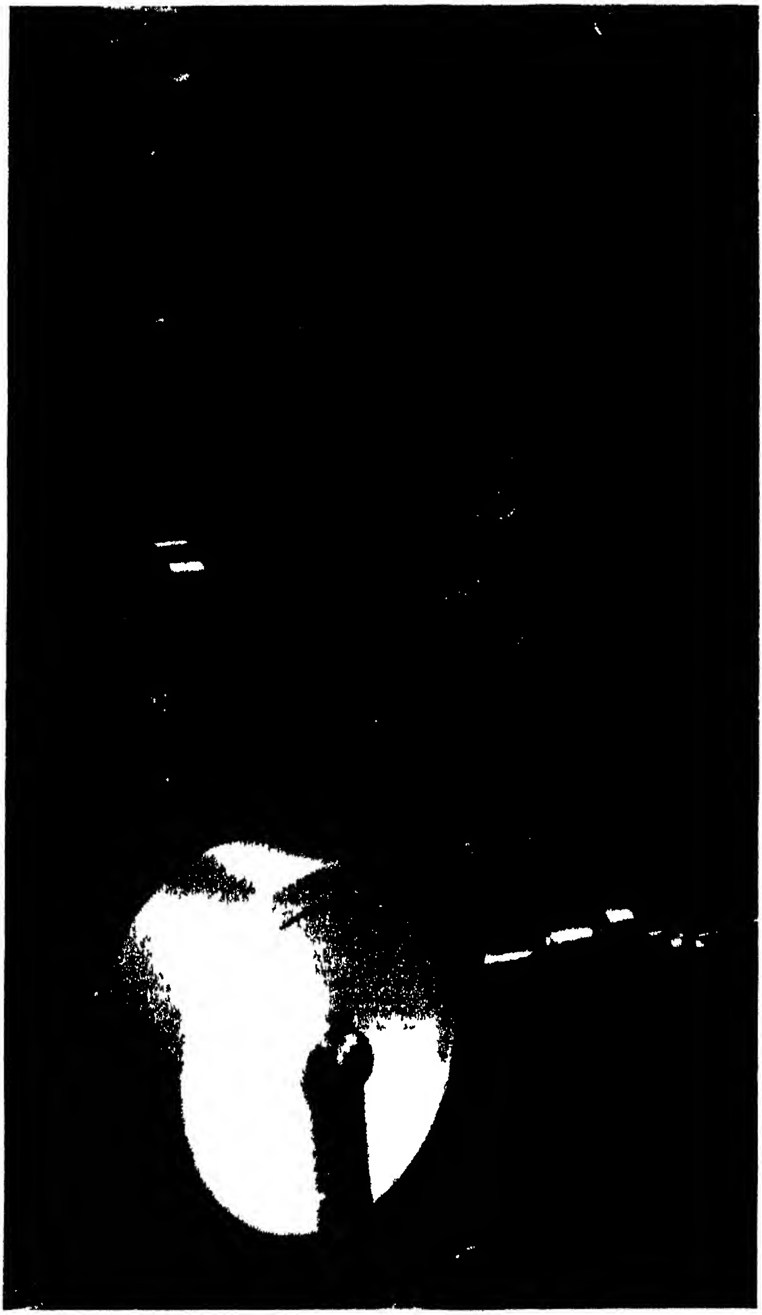


FIG. 3.

Interior of Turbine House, showing casing of turbine wheel, water pressure gauge, governor and fuse-board

message is sent to the house to ascertain that the other farm is not already using the power. The threshing seldom lasts more than one and a half hours at a time, as it is usually done in small quantities, the straw being used mainly for feeding purposes, and the more freshly threshed it is the better.

There is no doubt that on farms electric power is almost ideal for the machinery in the steading. No trouble has been given by either of the motors used for threshing and bruising, nor have they received any special attention. The ease and speed in starting machinery is one of the most noticeable features of electric power, and saves the time and energy which used to be expended on cranking engines or looking for faulty sparking plugs. The danger of fumes and fire is largely eliminated, more especially in connection with the lighting of the steading. The danger from oil lamps carried about the byres and barns can hardly be exaggerated; when electric current is used this danger is eliminated, superior illumination is obtained, and a more convenient system of placing lights can be devised. There is also a great saving of time and labour during the winter months in feeding and tending cattle; this the men appreciate especially at calving time. On a dairy farm increased efficiency would be very noticeable, and there is no doubt that even on a farm such as the Home Farm the dairymaid finds the light a great help for milking during the darker months of the year.

For chickens a reliable supply of electric current seems the most perfect form of heating that can be used. There is very little risk of fire, the atmosphere is kept clear of fumes, and an electric radiator is superior in every respect to an oil lamp or stove. On a farm of this type there is a distinct peak load during the early spring months when threshing and bruising are still in progress and chickens are being reared, but the power required for the chickens is practically a steady load throughout the 24 hours, which from the suppliers' point of view is an advantage. About 2,500 units were used last spring, which was especially cold, for rearing 350 chickens. The threshing load comes mainly during the winter months from the middle of October to April, and between the hours of 8 a.m. and 5 p.m.

The running expenses of the installation are not heavy, as very little has to be done to the turbine. It is examined once a day, and twice a week is stopped for a quarter of an hour or so for oiling and greasing. The ditch requires a certain amount of attention, especially near the mouth of the pipe, where one or two settling pools are formed which, as they become filled up, require to be cleaned out every few months.

The expense of wiring both of the steading and main cables is without doubt the difficulty which is hardest to overcome, as this very largely controls the price of the current. At Woodside the cost of wiring the two small houses and the steading, which holds about 25 to 30 cattle, was £65, excluding the overhead cable. On the two farms described the number of units used works out roughly at 220 units per 100 acres of arable land, which

in this part of the country includes land that is under temporary or rotation grass. This figure does not include poultry, as that is such a variable number on different farms. These two farms have mixed stock mainly of breeding sheep and cattle, and a dairy farm would probably use more current.

It seems improbable that electric power will be much used in the immediate future for field operations in view of the present elementary state of the necessary machinery. The load that might very suitably be added to the ordinary farm supply is the domestic load in the farm dwelling-houses, and as this would be quite considerable it would help to make the electrification of farms a more attractive proposition for the suppliers and a further benefit to the farmer. Indeed in many cases the farm load alone would not be sufficient to justify the expense of the installation unless current was also used for domestic purposes.

THE AGRICULTURAL OUTPUT OF SCOTLAND—II.

In the issue of the Journal for last October a summary was given of the changes that took place in Scottish agriculture between 1871 and 1925, as recorded in the Report on the Agricultural Output of Scotland recently issued by the Board.

The Thousand-acre Unit.—A comparison is also made in the Report between the distribution of land and live stock in 1913 and that in 1925, as disclosed by the Censuses of Production taken in these years. The figures are given in Tables 9, 10 and 11 of the Appendix to the Report, the system adopted being to take 1,000 acres of land under crops and permanent grass as the basis of calculation, and to give the number of agricultural holdings, the acreage of arable land and of permanent grass respectively and the number of each class of live stock per 1,000 acres (1) for each county, (2) for each of the five agricultural divisions,[1] and (3) for each of the six groups [2] in which holdings

[1] The Counties included in each Agricultural Division are as follows:—

Northern and North-Western - Shetland, Orkney, Caithness, Sutherland, Ross and Cromarty, Inverness.

North Eastern—Nairn, Moray, Banff, Aberdeen, Kincardine.

East Central—Angus, Perth, Clackmannan, Kinross, Fife.

South-Eastern—Midlothian, East Lothian, Berwick, Roxburgh, Selkirk, Peebles, West Lothian.

Western and South-Western—Argyll, Bute, Dumbarton, Stirling, Lanark, Renfrew, Ayr, Dumfries, Kirkcudbright, Wigtown.

[2] These groups are:—Above 1 and not exceeding 5 acres.
5 ,, 50 ,,
50 ,, 100 ,,
100 ,, 150 ,,
150 ,, 300 ,,
300 acres.

A closer analysis of the acreage and live stock figures for the year 1925 alone is given in Table 12, which covers the nine holdings groups regularly used in the Report, and enables the differences to be more precisely shown; see note on page 32.

were arranged according to size in tabulating the Census figures in 1913.

One thousand acres is a little over a square mile and a half, and it may conveniently be visualised either as a square block of land measuring a mile and a quarter on each side, or as a strip of land 6¼ miles long and a little over a quarter of a mile broad (to allow for the road), with a road running lengthwise through it, and 50 ten-acre fields on each side of the road,—say a two-hours' journey for a horse and cart. For international comparisons, it is roughly equal to 400 hectares, or a square block of land measuring two kilometres on each side.

This thousand acres consists, however, only of land under crops and permanent grass, and the question arises how to deal with the rough grazings, or "mountain and heath land used for grazing." This land can neither be ignored nor be treated as ordinary farm land. If the latter course were followed, as it was in the Report on the Census of 1908, the distribution of horses, cattle and pigs would be reduced to an absurdly low figure, which would quite fail to do justice to Scotland in comparison with other countries. On the other hand, the existence of this large area of rough grazings seriously affects the figures for sheep, and to a less extent those for cattle, in the crofting counties. The plan adopted in the tables is to give separately the acreage of rough grazings per 1,000 acres of land under crops and grass. This may be ignored in considering the figures for horses and pigs and those for cattle in most parts of the country, but it must be taken into account in considering those for sheep, which as given in the tables on the basis of land under crops and grass are generally much too high.

Number and Size of Holdings.—If the 1,000 acres of land under crops and grass are regarded as a large farm, the corresponding area of rough grazings, which for Scotland as a whole in 1925 averaged 2,050 acres, may be regarded as "outrun" attached to it. It is, however, more reasonable to regard the 1,000 acres of land as a small estate (no suggestion being made that estates of this size actually exist in all parts of Scotland), and the first question that arises is—how many farms and small holdings are comprised in it? The answer for Scotland as a whole is 16, and the corresponding "average size of holding" is 62 acres. The latter figure has been criticized as meaningless, and it may be conceded that it is in itself a mere arithmetical average. The only value of such figures lies in their comparative amount. To say that the "average size of holding" in Berwickshire is nearly 200 acres, in Ayrshire nearly 100 acres, and in Sutherland 12 acres, does give a rough measure of the scale of the agricultural unit in each of these counties.[1]

Further light is thrown on this subject by Table 23, which gives for each county the number and total acreage of the hold-

[1] A truer measure is given by stating the acreage of the typical or "modal" holding, i.e. the type that is most prevalent or most characteristic. To ascertain this requires further statistical analysis. There may be more than one "mode" in a given group.

ings in each of nine size-groups, with the percentage in each case.[1] Thus the 244 farms in Berwickshire having over 300 acres of land under crops and grass comprise no less than 71 per cent. of the whole area of such land in the county, their average size being 550 acres. In Ayrshire again the 637 farms in the group "150 to 300 acres" comprise 40 per cent. of the county's farm land, their average size being nearly 200 acres, while the 653 farms in the group "100 to 150 acres" comprise 26 per cent. of the farm land, their average being 125 acres. In Sutherland 36 per cent. of the whole acreage of land under crops and grass is comprised in the groups "1 to 5 acres" and "5 to 15 acres."

Returning to the "estate" of 1,000 acres, we find that in Berwickshire it will contain only about five holdings and in Ayrshire 10, while in Sutherland it will contain 80 and in Shetland no fewer than 120. The figures for the five agricultural divisions given in Table 10 show fairly well the prevailing types of the distribution of agricultural land. The figure for the south-eastern division is 6½, for the east central 10½, for the western and south-western 12½, for the north-eastern 16½, and for the northern and north-western 47½. The corresponding figures for holdings groups given in Table 11 have no significance, since they are determined by the mere fact of division into groups.

Arable and Grass Land.—The next point illustrated in these tables is the proportionate areas of arable land and land under permanent grass. The Scottish average figures are 686 acres of the former and 314 of the latter. As compared with 1913 there is a very slight increase in the area under permanent grass. The five counties in the north-eastern division—Kincardine, Aberdeen, Banff, Moray and Nairn—show figures for arable land varying from 940 to 920, while the minimum figure is 390 in Renfrew. This is one of the points in which Scotland differs markedly from England and Wales. There the average figures in 1925 were 415 acres of arable land and 585 acres of land under permanent grass. It was then quite a reasonable thing to classify the English and Welsh holdings of 20 acres and over as "mainly arable" with 70 per cent. or more of arable land, "mainly pasture" with 70 per cent. or more of permanent grass, and "mixed holdings" between these two.[2]

The divisional figures for Scotland given in Table 10 show 933 acres of arable land in the north-eastern division, 738 in the east central, 717 in the northern and north-western, 650 in the south-eastern, and 498 in the western and south-western. Not even in the last-named division does the average farm consist "mainly of pasture land." When, however, the area under rotation grasses and clover is added to that under permanent grass, the two countries approach one another much more nearly. In England and Wales in 1925 the combined acreage

[1] The corresponding figures for 1913 will be found in the Agricultural Statistics for that year, Part I, Table 12, in which district as well as county figures are given. It was thought to be unnecessary to go into so great detail on this occasion.

[2] See *The Agricultural Output of England and Wales*, page 85.

of grass of both kinds per 1,000 acres was 685 and that of "tillage" 315, while in Scotland the corresponding figures are 633 and 367.

Turning to Table 11, we find that there is much less variation in the figures for holdings groups than there is in the divisional figures. The minimum figure for arable land is 648 acres in the group "1 to 5 acres," and the maximum 722 in the group "50 to 100 acres." The range on each side of the Scottish average is in this case about 5½ per cent., while the divisional figures range from 36 per cent. above to 27 per cent. below that average. The proportion of land that is under rotation is a matter of locality and not of size of holding.

Rough Grazings.—In Scotland as a whole there are 2,050 acres of rough grazings per 1,000 acres of land under crops and grass. The western and south-western division shows the nearest figure to this average, 2,125 acres. In the east central division it is 1,315, and in the south-eastern 1,004, while in the north-eastern the very low figure of 444 is recorded. Much the highest figure is that for the northern and north-western division, 7,285 acres. Among the counties, Sutherland stands pre-eminent with 28,000 acres, Shetland and Argyll coming next with about 12,000. Fife and West Lothian show the minimum figures, 74 and 86 acres respectively. Thus our "estate" will in the north-eastern division comprise about 1,450 acres, of which more than two-thirds is ordinary farm land, the rough grazings forming a mere adjunct, while in the north-west it will run to about 8,300 acres, or 13 square miles, of which less than one-eighth is ordinary farm land.

The holdings groups also show wide variations. Many of the so-called "small holdings" are really large sheep farms with a small area of arable land and permanent grass, while crofters' common grazings are generally attached to holdings of the smaller type. Hence the holdings from 1 to 5 acres show the high figure of 14,000 acres, and those from 5 to 15 acres 5,900, while farms above 300 acres have only 530 acres of rough grazings per 1,000 acres of land under crops and grass.

Live Stock.—The remaining columns of the tables give the numbers of each class of live stock per 1,000 acres.

Horses are abnormally numerous in the crofting counties. This is accounted for by the large use of ponies, and by the fact that the horses and ponies kept are not fully employed. In the other counties the figures range from 55 per 1,000 acres in Nairn and 51 in Banff to 22 in Selkirk and 21 in Peebles, the average for Scotland being 39,[1] or four less than in 1913. This decrease is wholly accounted for by horses other than those used for agricultural purposes, the latter class having just kept pace with the change in the acreage under crops and grass. The divisional figures for the total number of horses range from 59 in the northern and north-western to 28 in the south-eastern, and those

[1] Attention may here be drawn to an error on page 29 of *The Agricultural Output of Scotland*, where this figure is given as 31.

for horses used for agricultural purposes from 44 to 21 in the same divisions. The figures for groups of holdings show a wide range from the smallest to the largest holdings, those from 1 to 5 acres having a total horse population of 89 per 1,000 acres, while those above 300 acres have one of 26. Horses used for agricultural purposes similarly range from 52 to 19. A pair of horses works 25 acres of arable land on a holding less than 50 acres, while on a holding above 300 acres it works 70 acres, the average for Scotland being 47.

Cattle.—The total number per 1,000 acres shows a slight decrease since 1913, the diminution of "other cattle" from 170 to 160 being partly set off by an increase in the number of dairy and breeding cattle from 90 to 96. Apart from the crofting counties and Bute, where the figures are exaggerated, as explained above, the highest figures for the total number of cattle are in Wigtown, 372; Ayr, 342; Kirkcudbright, 318; and Renfrew, 309. The figures for the south-eastern and east central counties are relatively low, owing to the fact that the returns taken on 4th June fail to do justice to these counties as feeding areas. The divisional figures range from 324 in the western and south-western division to 143 in the south-eastern. The former division naturally shows also the highest figures for dairy and breeding cattle, 157, while the north-eastern division has the largest number of "other cattle," 201. The south-eastern division shows between 1913 and 1925 an increase in its total cattle population from 131 to 143 (9·2 per cent.), and the western and south-western division a small increase; in the other divisions the number was diminished.

Among the holdings groups, the number of cattle per 1,000 acres decreases from the smallest holdings to the largest, but the figures for the former class are exaggerated owing to the existence in connection with them of rough grazings. Holdings from 50 to 300 acres show total numbers of cattle not differing very widely from the Scottish average, while holdings above 300 acres show a marked deficiency, particularly in the case of dairy and breeding cattle, which number only 50 per 1,000 acres. The increase between 1913 and 1925 in the number of this class is, however, most conspicuous in the larger types of holdings, as is shown in the following table.

Numbers of Dairy and Breeding Cattle per 1,000 Acres.

Holdings.	1913.	1925.	Difference.	
			Actual.	Per cent.
1 to 5 acres	346	316	−30	− 8·7
5 ,, 50 ,, ...	145	137	− 8	− 5·5
50 ,, 100 ,, ...	106	109	+ 3	+ 2·9
100 ,, 150 ,, ...	98	109	+11	+11·1
150 ,, 300 ,, ...	77	87	+10	+13·0
Above 300	42	50	+ 8	+19·0
All holdings	90	96	+ 6	+ 6·7

The figures for "other cattle" are more uniform in their tendency, the groups of holdings between 50 and 300 acres showing decreases between 1913 and 1925 of 6 to 7 per cent., while the decrease on smaller holdings exceeds this amount, and holdings above 300 acres show the relatively small decrease of 2·3 per cent.

Sheep.—The figures for sheep should, as already explained, be read in conjunction with the area of rough grazings as well as with that of land under crops and grass. Extremely high figures are shown for Argyll, Inverness, Sutherland, Shetland, Peebles and Selkirk. At the other end of the scale come the north-eastern counties, with Fife, Orkney, Renfrew and West Lothian, where the index number is one-third or less of the average for Scotland. It is notable that Roxburgh, with about three-fifths of the general proportion of rough grazings, still has double the average number of sheep.

A calculation has been made of the extent to which sheep are carried on ordinary farm land and rough grazings respectively, based on the returns of flocks exceeding 500 at 4th June 1925. The conclusion is that, of the 7,119,000 sheep returned on that date, 1,547,000 were on holdings consisting mainly of ordinary farm land and 5,572,000 on holdings consisting mainly of rough grazings.

The average number of sheep for Scotland as a whole per 1,000 acres of land under crops and grass, with 2,050 acres of rough grazings, in 1925 was 1,513, showing an increase over 1913 of 95, or 6·7 per cent. The divisional figures in Table 10 show wide variations, the northern and north-western and the south-eastern divisions having 2,392 and 2,291 respectively, while the figure for the north-eastern is only 446. It is in the last-named division, however, that the greatest proportional increase took place between 1913 and 1925, amounting to 66, or 17·4 per cent.

Among the holdings groups, much the highest figure is shown by holdings from 1 to 5 acres, owing to the very large proportion of rough grazings associated with them. Holdings from 5 to 50 acres, for the same reason, have about double the general average. Those from 50 to 100 acres and those above 300 acres are about the average, while the groups "100 to 150 acres" and "150 to 300 acres" carry only about two-thirds of the average number. The group "100 to 150 acres" shows a decrease between 1913 and 1925, while of the others the largest increases are shown by the very largest and the very smallest holdings.

Pigs show an increase of nearly 20 per cent. in the number per 1,000 acres as compared with 1913, but the index number 33 is still very low as compared with that for England and Wales, viz. 103. The outstanding counties are Midlothian, Wigtown and Kirkcudbright, where the figures range from 118 to 77. The crofting counties and the pastoral counties of Peebles and Selkirk show exceptionally low figures. The increase in number is most marked in the north-eastern and the south-eastern divisions, and the predominance of the western and south-western is less clear

than it was in 1913. Among the holdings groups that from 1 to 5 acres shows the high index figure of 96, the others varying little from the average. The increase since 1913 is most clearly shown in the group "above 300 acres," where it amounts to nearly 40 per cent.

Poultry.—A separate set of tables deals with poultry, which form a comparatively recent addition to the "live stock" enumerated annually on 4th June. The figures of distribution are given only for the year 1925, and the full range of nine holdings groups [1] is used.

Special returns of poultry were obtained for the Agricultural Censuses of 1908 and 1913, and since 1921 they have been regularly included in the Agricultural Returns. The following table shows the total numbers of each kind returned in 1908, 1913, 1921 and 1925. The returns include only poultry on agricultural holdings exceeding one acre of land under crops or grass.

Numbers of each kind of Poultry in Scotland.

(Numbers are in thousands.)

Year.	Fowls.	Ducks.	Geese.	Turkeys.
1908	4,107	294	26	69
1913	4,054	209	21	57
1921	4,216	240	23	70
1925	5,366	260	23	77

The returns for the two earlier years are probably not of the same degree of accuracy as those for the later years. Fowls show a substantial increase, amounting to about 30 per cent., between 1921 and 1925, while ducks, geese and turkeys show less change, but have maintained their numbers fairly well throughout the whole period.

Table 19 in the Appendix shows the number of fowls and ducks in each county in 1925, with the number per 1,000 acres of land under crops and grass. The number of fowls per 1,000 acres ranges from 2,892 in Orkney to 517 in East Lothian, the Scottish average being 1,140. The divisional figures are given in Table 20, which covers also geese and turkeys. Fowls range from 1,676 in the northern and north-eastern division to 696 in the south-eastern, ducks from 110 to 24 in the same divisions, and geese from 10 to 1. Turkeys are most numerous in the north-eastern division, with an index number of 35, the south-eastern having only 6. Table 21 shows that the density of poultry stock

[1] These groups are:—Above 1 and not exceeding 5 acres.
" 5 " 15 "
" 15 " 30 "
" 30 " 50 "
" 50 " 75 "
" 75 " 100 "
" 100 " 150 "
" 150 " 300 "
" 300 acres.

Not a lamb or ewe lost—

thanks to Osmonds!

MAKE this the most successful lambing season you have ever had. Don't anxiously trust to luck. Get an OSMONDS' Lambing Chest and prepare the way at each stage. First give the ewe OSMONDS' Oils to prevent heaving and straining; then anoint the womb externally with the same oil. After lambing administer OSMONDS' Ewe Drench. This will carry off the cleansing, prevent milk fever, and enable the ewe to suckle the lambs better. For continued weakness afterwards, or weakly and scouring lambs, give a dose of OSMONDS' Brown Draught.

In case of Chills, Fever, Red Water, etc., OSMONDS' Electra Fluid will vitalize both ewe and lamb.

For emergencies there is OSMONDS' Chlorosyl for bad heaving or straining, severe pain, inflammation, etc.

In each chest there is just the right quantity of each medicine to see you through; any unopened bottles left over will keep well till next year. Prices 27/6 and 51/- a chest, the larger size containing twice as much as the smaller. Medicines can also be supplied separately. These Osmonds' remedies have been tested and enthusiastically recommended by shepherds for over 50 years. Full directions on each bottle enable the most inexperienced to use them successfully. Make certain of success this year. Write for full particulars of OSMONDS' Lambing Chest.

OSMOND & SON LTD.

GT GRIMSBY, ENGLAND.

Branches all over the World

Manufacturers of Animal Medicines for over 70 years

varies inversely with the size of holdings. The group "1 to 5 acres," although 30 per cent. of its area carries no poultry, shows for fowls a density over the whole area six times the Scottish average, while farms over 300 acres show a density only one-third of that average.

Labour.—The same principle is used in Tables 24 and 25, which give the number of workers of each class per 1,000 acres of land under crops and grass in each division and each of nine holdings groups respectively as returned in 1925. The occupier of the holding, his wife and domestic servants are excluded. The index number of all workers for Scotland on a whole is 26, and the divisional figures show a comparatively small range of difference from this average. The exclusion of occupiers and their wives, however, produces a greater effect in the regions of small holdings and small farms than in those of large farms. The inclusion of all persons engaged in agricultural work would considerably increase the figure for the northern and north-western division, and would to a less extent raise those for the north-eastern and the western and south-western. Regular male workers are most numerous in the north-eastern division and least in the western and south-western, while female workers show a marked deficiency in the north-eastern and the east central. Men over 21 are most numerous in the east central and south-eastern divisions, and younger men in the north-eastern. The latter show a much larger range of variation between the divisions than the former; the index number for Scotland is 4·8, while in the north-eastern division it is 6·7, and in the south-eastern 3·8.

Casual workers are nearly three times as numerous in the western and south-western division as in the north-eastern. At the date of the return, 4th June, in the country as a whole one casual worker was employed for every five regular workers.

The distribution by holdings groups shows a wider range of variation than that by divisions. The distribution on holdings from 1 to 15 acres reflects a variety of conditions that makes their interpretation somewhat doubtful. Above that limit the figures are more completely comparable. The figure that shows least variation throughout is that of regular male workers over 21, who are, however, somewhat more numerous on holdings over 150 acres than on those between 15 and 150 acres. Regular male workers under 21 reach their maximum on holdings between 50 and 150 acres, while regular female workers diminish almost continuously from the smallest holdings to the largest, as do casual workers of both sexes.

The average for Scotland being 26 workers of all kinds per 1,000 acres, it may be said that holdings between 30 and 150 acres conform fairly closely to this figure, while on smaller holdings it is exceeded by 30 to 50 per cent., and on larger holdings the figure is lower by from 5 to 12½ per cent. Including employers and persons working on their own account, the average number engaged per 1,000 acres is 38.

THE CROFTING PROBLEM, 1780-1883.

MARGARET M. LEIGH, M.A.

VII.—THE DECLINE OF SHEEP-FARMING AND INCREASE OF DEER FORESTS.

THE greater number of deer forests in the Highlands were made between 1850 and 1880, by the simple process of removing sheep and encouraging deer to multiply. This process was made possible, and even necessary from the landlord's point of view, by the waning prosperity of sheep-farming. The competition of Colonial wool and mutton had lowered the price of the British products, while the farmer's expenses had increased. Most hill-farmers wintered their young stock away, which involved much expenditure; while the custom of taking over flocks at acclimatisation value often meant that the ingoing tenant paid as much as £1 a head above current market prices. Many pastures, which had long been under sheep alone, showed signs of deterioration. It was not unusual for a farmer, if at the end of his lease sheep were fetching a fairly good price, to decline a renewal. Thus the landlord would have the place on his hands, with the risk of having to take over the stock at valuation, if no fresh tenant were forthcoming.

The increase of land under deer was a favourite topic with the land agitators, and the public were not allowed to lose sight of it. In 1872-3 a Select Committee was appointed to enquire into the question. They reported that the growth of deer forests had not caused depopulation, nor had the food supply been appreciably diminished, since it was reckoned that not more than 400,000 sheep had been displaced. The Commission of 1883 investigated the matter again, and came to much the same conclusions. They found that, with unimportant exceptions, the forests had been formed not by the dispossession of small tenants, but by the conversion of large sheep-farms. The permanent staff employed by the sheep-farmer and the sporting tenant was about the same.

The Commissioners of 1883 showed themselves a little too indulgent to sporting interests. Their hope that the area under deer would not be increased has not been fulfilled. Between 1883 and 1908 the deer forests in Argyll, Ross and Cromarty, Sutherland, Caithness, Inverness, Orkney and Shetland have increased as follows :—[1]

1883	 1,709,892	acres.
1898	 2,510,625	,,
1904	 2,920,097	,,
1908	 2,958,490	,,

In 1892 the Royal Commission (Highlands and Islands) made enquiry on the proportion of land in these counties then occupied for sport and grazing which would be suitable for small holdings. After three years of investigation they reported that there were

[1] *Report on Scottish Land*, 1914, p. 174.

1,782,785 acres used for sport and grazing which could be made available for holdings.[1] From an analysis of the figures given in the Report it has been ascertained that the actual area under deer forests was about 325,000 acres.

Unfortunately, it is impossible to discuss sport and agriculture without raising moral and political issues which have often little to do with the purely economic side of the question. The Commissioners of 1883 included several members of the landed class, while the authors of the Report of 1914 were appointed by a Liberal Chancellor of the Exchequer; and the divergence of view revealed by the two Reports may be explained by other causes than a change in economic conditions. Yet it is impossible to isolate the economic aspect from all others. It must be admitted that in the occupation of rural land, food production and the maintenance of the agricultural population should come before the amusements of a small minority, and that the money spent and labour employed in the district cannot in the long run be economically justified if it is not directed to some productive end. And there is little doubt that agricultural and sporting interests are fundamentally opposed. The preservation of game restricts and damages the farmer, while the existence of agricultural holdings on the fringe of a deer forest is a constant annoyance to the proprietor. This point comes out clearly as early as the seventeenth century. In 1617 a statute was passed for the protection of "forests within the realm in which deer are kept, and which are altogether wasted and decayed by sheallings, pasturing of horses, mares, cattle, oxen and other bestial, cutting of woods within the bounds of the said forest, shooting and slaying of deer and wild fowls with hagbuttis and with dogs in forbidden time" (Acts of Parl. IV, p. 548). This was in the days when Highlanders enjoyed unlimited grazing on the hills, and the sportsman rather than the crofter needed legal protection. Examples from advertisements have been collected in the Report of 1914, where the chief recommendation of a sporting estate is that it has a few or no crofters upon it. The whole question is well summed up by Sir John Stirling-Maxwell, himself the owner of a forest of 56,521 acres :—"It may be true, I believe it often is, that a deer forest employs more people than the same area under sheep. It certainly brings in a larger rent. From a purely parochial point of view it may therefore claim to be economically sound, but from no other. It provides a healthy existence for a small group of people, but it produces nothing but a small quantity of venison, for which there is no demand. It causes money to change hands. A pack of cards can do that. I doubt whether it could be said of a single deer forest, however barren and remote, that it could serve no better purpose." (*Estate Magazine*, Sept. 1913.)

In the Report of 1883 sheep or black cattle were regarded as the only rivals of the deer. There is no word of forestry. Now the Royal Commission on Coast Erosion and Afforestation (1909)

[1] House of Commons Papers, c. 7681, 1895, p. xxii.

found that in Scotland no less than 6,000,000 acres, mostly situated in the Highlands, were suitable for planting. For this purpose there is required not agricultural land, but rough moorland at a medium altitude, and much of this could be supplied from existing deer forests.

The advantage to the crofter is obvious. Not merely do belts of trees provide shelter for stock in winter, but the work of sylviculture provides employment for the small-holder and his horses at a time when his holding needs least attention, thus forming an ideal subsidiary occupation. A sound scheme of afforestation would always include the development of small-holdings for part-time forestry workers. To enlarge further on this subject would be to go beyond the bounds of the period, but it will be seen that at the present day the advocates of deer forests have a poorer case than ever. We may conclude by quoting from the Report of the Royal Commission :—

> "At certain seasons, notably in spring and summer, the occupier of a small-holding may be fully engaged with his own business; but at other times, such as late autumn and winter, his holding may require but little attention beyond such as can be given by his wife and family, and then he is glad to find supplementary work in the neighbourhood. But as the time when he can be spared from his holding coincides with the time when farm work is least pressing, it is obvious that his services are not likely to be demanded by farmers. The case, however, is otherwise with forestry. It is precisely when the small-holder has leisure that sylviculture is most insistent on a supply of labour, and it is therefore not surprising that your Commissioners have had much evidence put before them of the natural relationship that exists between small-holdings and forestry. And similarly with regard to the relations between forestry and agriculture. Men engaged in sylviculture can often readily be spared from the woods in June, July and August, when hay-making, the hoeing of roots and harvest operations are in full swing, and with a little organisation, farmers could obtain extra hands at precisely the time of year when, if at all, they require extra help."

The labour required for the maintenance of a deer forest was roughly the same as for a sheep farm, while more seasonal employment was given by the former. The question of the loss to the nation's food supply was carefully examined. Taking one sheep to every five acres—a reasonable allowance on poor hill pasture—a witness unfavourable to sporting interests calculated that deer might have displaced 320,000 sheep. According to a favourable witness, the number was 335,000, while the Secretary to the Commission reckoned it as 395,000. Compared with the total number of sheep and fleeces used to supply the markets of Britain, the number is of course negligible; but the argument in the Report, that owing to our vast resources from overseas we

could afford to lose 400,000 Highland sheep, though true as far as it goes, might be extended to justify the conversion of the whole of these islands into a sportsman's paradise.

The other objections to deer forests are less serious. Some instances were given of damage done by deer to crops on small-holdings adjoining forests,[1] but complaints of this kind were much more common in the eastern districts, where ground game were more troublesome than deer. In any case, adequate fencing could be erected by the owner of the forest, and this should have been made obligatory. It was also alleged that land under deer deteriorated rapidly, owing to their habits of grazing and the neglect of heather-burning; but land exclusively under sheep does the same, and there was nothing to prevent systematic heather-burning if desired. The arguments about the demoralizing life of ghillies are not very conclusive; more serious is the contention that the increase of sporting tenancies widened the gap between the social classes in the Highlands. Between the proprietor and the small tenants there were no representatives of the middle class except the factor, the doctor, the minister and the schoolmaster. But this evil existed in the sheep-farming days, when many large farmers were non-resident, and exists to-day in districts where there are no deer forests. It is perhaps inevitable in a country where there are few medium-sized farms or middle-class occupations. In any case, the landlords had got out of touch with their tenantry long before they began letting their land for sport.

The system had brought two immediate advantages to the crofters. The deer forest, being rented high, contributed the greater part of the rental of the estate, so that the heavier burden of rates was shifted from the small tenants to the sporting tenant. Also, the building and upkeep of lodges, roads and so forth involved the spending of much money and the employment of much labour in the district.

Thus the Commissioners concluded that existing deer forests were not anti-social in their effects, but deprecated the extension of the area under deer.

VIII.—EVENTS LEADING UP TO THE APPOINTMENT OF THE CROFTERS' COMMISSION OF 1883.

Between 1851 and 1883 the general condition of the crofters improved. Except in Lewis, where the land available was yearly becoming more congested, the population was steadily declining. The spread of education and increased facilities for emigration were drawing larger numbers of young people to the south and overseas, and checking the demand for land unobtainable at home. The chief agricultural movement of the period, the conversion of sheep farms into deer forest, left the crofting class

[1] According to the Old Statistical Account much damage was done by deer to the corn and grass of crofters in Harris (x, p. 358).

much as it was, while some of the worst abuses of the old system were tending to disappear. Many landlords were alive to their responsibilities, and when able to afford it were not slow to attempt improvement.[1] Runrig had been abolished almost everywhere, while casualties and services had in most cases been commuted. Efforts were made, though often in vain, to check subdivision and squatting by estate regulations. Though the landlord had the theoretical right to raise rents at pleasure, in practice he was often indulgent, especially in the matter of arrears, which were sometimes allowed to accumulate for many years before eviction. Nor had the Highlands failed to share in the general improvement in transport, education and sanitation.

Yet these very advantages made the crofters more keenly alive to the hardships of their lot. Contact with the outer world and the knowledge of other modes of living inevitably raise the standard of life in remote districts, and letters from successful emigrants must have stimulated the desire for prosperity. At the same time it must be realised that the land agitation in the Highlands began not among the crofters themselves, but among the intellectuals in the towns, many of whom may have been born in a Hebridean black house. At this time agrarian discontent was in the air. The passing of the Irish Land Act in 1881 drew public attention to the claims of the remote west. In the crofting counties of Scotland the climatic and social conditions were not unlike those prevailing in the west of Ireland, except that there was little demand for ownership of land and little political exasperation. It was natural therefore that the granting of the " three F's " to the Irish peasantry should make Highlanders demand some similar concession for themselves. From London, Glasgow and Edinburgh issued a flood of controversial pamphlets and letters to the press. At Inverness the historian Alexander Mackenzie founded the Highland Land Law Reform Association,[2] which was followed by the formation of similar societies in Edinburgh and London. In 1882, Mackenzie made a propagandist tour of the West Highlands and Islands. In 1883, Sir D. H. Macfarlane, member for Carlow in Ireland, proposed in Parliament the appointment of a Royal Commission to enquire into the condition of the crofters; the proposal was accepted by Gladstone's government. In 1884 the local societies were federated into a single body, the Highland Land Law Reform Association. Its objects were (1) to restore to the crofters by constitutional means their hereditary right to the land; (2) to check depopulation caused by eviction or forced emigration; (3) to reform the game laws. Annual conferences were to be held, of which the first met at Dingwall in 1884. After it J. Stuart Glennie, accompanied by a Skye crofter and

[1] Large sums were spent by the Duke of Sutherland and Colonel Matheson, the proprietor of Lewis, on the improvement of their estates; unfortunately, the results were disappointing.

[2] Particulars of these activities are given by C. Guernier, *Les crofters écossais*, 1897, p. 99. He derived his information from one of the chief participators, J. Stuart Glennie.

a minister, toured the crofting districts holding meetings. In view of the forthcoming elections a large meeting was held at Bonar Bridge, which resolved to support no candidate, whether Liberal or Conservative, who was either a landlord or the son of a landlord. At Portree there was a great demonstration, and 7,000 Highlanders with an appropriate number of pipers bound themselves to the cause of land reform. As a result of this campaign the Highland constituencies returned no less than sixteen members pledged to support the crofters' interests in Parliament. Nor did the crofters leave their cause entirely in the hands of the intellectuals. As early as 1874 a group of small tenants from Bernera (Lewis), who had been arbitrarily removed by the factor without the proprietor's sanction, brought the matter into Court, and the judge was surprised to hear that the factor considered the question of too small importance to bring before his employer. From time to time crofters would put their own stock upon land belonging to sheep farms or deer forests, which they claimed as theirs by ancient right. This practice was sometimes winked at and sometimes resisted. In 1881 a number of crofters from Braes, near Portree, seized a pasture from which they had previously been evicted. Feeling ran high and the authorities, fearing trouble, sent a force of a hundred police. A riot followed, in which several policemen were injured. Two years later there were disturbances of the same sort at Kilmuir and other places in Skye. The local authorities, no doubt afraid of an outbreak of Fenianism, asked for a force of armed police and even for a gunboat. Large crowds marched to and fro, uttering fearful yells which, according to the police inspector at Portree, reverberated terribly in the glens. The police were asked to bring their coffins with them, and some received a few kicks, but otherwise nothing of great importance happened. These disturbances, however, directed public attention to the condition of the Western Highlands, and gave additional weight to the demand for a Royal Commission.

At this point the crofting problem entered upon its final phase. For good or ill, the Highlands have come more into line with the rest of the country, and are no longer regarded as an isolated survival of the Middle Ages. Hence in the treatment of its social and economic problems Government intervention tends to take the place of individual effort. It is difficult to separate the legislation of the later nineteenth from that of the earlier twentieth century, and perhaps it is too early to form any judgment on either. But it must be remembered that no policy, however comprehensive and enlightened, can alter the fundamental conditions of soil, climate and distribution of population, which make the problem of small holdings in the West Highlands one of the most difficult questions in Scottish agricultural economics.

OAT-SICK LAND IN RELATION TO EELWORM DISEASE.

DAVID ROBERTSON, B.Sc. (Agr.), N.D.A., Ph.D.,
North of Scotland College of Agriculture.

Introduction.—In 1926 a survey of the distribution of eelworm disease, caused by *Anguillulina dipsaci* (Kühn, 1857), in the north of Scotland was attempted. Circulars were forwarded to the various county organisers requesting them to send in samples and particulars as to the extent of eelworm infection in oats in their districts. Of the total samples sent in 36 per cent. proved to be infected with eelworm; the remainder had failed through other causes, but eelworm had been put down as the cause of the failure in many cases. The acreage of oats in the north of Scotland affected in this way is by no means small, and although confined mostly to Orkney the disease is also prevalent in the Western Isles and in districts on the north-east coast of Scotland.

In nearly every case the disease is found in lands near the coast, and is said to be connected with the practice of manuring the soil with sea-weed, shell sand or "fisher dung" (fish refuse and cockle shells). Such soils are commonly known as "oat-sick" on account of the unhealthy corn plants they produce, and this soil condition has been known for at least twenty-five years.

Publications on the subject are few and consist chiefly of the results of experiments on the treatment of oats on oat-sick land carried out during 1911, 1912 and 1914.[1] There is no record of further experiments having been carried out since 1914, and very little additional light has been thrown on the problem of oat-sick land.

The Cause of Failure of Oats in Oat-sick Land.—None of the early reports mention eelworms as a probable cause of the oat's failure in the soil, but since then it appears that many agriculturists believe that this is the case, and the particulars sent in with the samples in the Survey are proof of the prevalence of this opinion. The origin of this belief can probably be attributed to three causes :—

(1) Oats growing on oat-sick soil and oats infected with *A. dipsaci* have several symptoms in common.

(2) The word "segging" is applied to both oats from oat-sick soil and to eelworm diseased oats. In the latter case "segging" means "sedging," from the sedge-like appearance and tufted condition of the leaves, but as used in reference to oats from oat-sick soil it refers to the fact that the leaves droop or sag in a characteristic manner. The fact that the same term is applied to two entirely different diseases must necessarily lead to confusion.

[1] North of Scotland College of Agriculture Leaflets (Report on Field Experiments and Demonstration Plots).

(3) The occurrence of semi-parasitic species of nematodes in oats from oat-sick soil. Without doubt this fact has led to mistakes regarding the true cause of the plant's failure. Investigations prove that the mere observation of eelworm in an unhealthy oat plant is not sufficient reason for saying that eelworms are the cause of its failure. The nature and number of the species present are of unquestionable importance in the diagnosis of nematode disease in plants.

The number of Nematodes in Oat-sick Soil.—I do not go so far as to say that the oats are failing in Orkney through the same cause as those on the coast of Kincardineshire, since I have not had the opportunity of visiting Orkney to observe the conditions and the growth of oats there; nor have I drawn any comparison between the chemical analysis of these so-called oat-sick soils. Nevertheless I am in a position to state from my personal observations in the field that nematodes are never the cause of failure in oats on oat-sick land, and that there is no truth in the statement that eelworm infested oats are associated with such soils.

I cannot find any relationship whatever between the presence of *A. dipsaci* in soils and the application of sea-weed, shell sand or fisher dung. I have made five examinations of the numbers and species of nematodes in various oat-sick land soils, and the species have in no way differed from those found in inland farms where oats grew normally and well. The following figures give the numbers of nematodes per cubic inch found at a depth of six inches in oat-sick and in ordinary soils :—

Soil growing healthy Oats.	*Oat-sick Soil.*
65	53
60	29
55	67
74	58
81	38

Out of the five examinations made, *A. dipsaci* has been recorded in two, and neither of these lands has grown eelworm diseased oats. The same cannot be said of the results found in normal soils, which are very seldom without a small number of this species. It may be stated then that in oat-sick soils the numbers of nematodes are less, and that the species *A. dipsaci* are seldom present. The belief, therefore, that eelworms (*A. dipsaci*) find specially favourable conditions for increasing in oat-sick soil must be regarded as misleading and without foundation.

So far I have never been able to discover eelworm infested oats on oat-sick soil, but I have found failure in oats due to *A. dipsaci* and failure in oats due to oat-sick soil on the same farm. Without doubt this is merely a coincidence, but it tends to lead to confusion.

Eelworm diseased Oats compared with Oats from Oat-sick Soil.—Oats from oat-sick soil, like eelworm diseased oats, have a stunted appearance due to poor development of the nodes; but they never on any occasion show swelling of the leaves or stem, a symptom always present in oat plants infested with *A. dipsaci*. The roots are in proportion to the growth of the plant, while in eelworm diseased oats the roots disappear at an early stage or remain poorly developed. The leaves in eelworm diseased plants grow straight and rigid in contrast to the drooping leaves of oats from oat-sick soil. The stage when decay sets in with oats from oat-sick soil seems to vary. Along the coast of Kincardineshire the plants generally begin to droop and wither when two to four inches in height and never reach the stage of putting forth an ear. In Orkney and other counties the plants may reach the stage of shooting, but the ear and grains remain poorly developed.

An important difference between an area of eelworm disease and one of oat-sick land is that the former shows a mixture of tall and stunted plants, while the latter, owing to the growth of each plant having been equally affected by the condition of the soil, presents a uniformly diseased appearance which is very noticeable even at a distance.

Species of Nematodes inhabiting Oats from Oat-sick Soil.—It is well known that there are in the soil nematodes which flourish on unhealthy and decaying plants. This accounts for the finding of numbers of semi-parasitic nematodes between the leaves and in the tissues of oats from oat-sick soil. The fact that seedlings on such land begin to wither and decay when the plant is in the early stages of growth allows of easy movement and suitable conditions of development for these nematodes.

Frequently I have found unhealthy oat-sick-soil oats with large numbers of these semi-parasites, and in such cases it is possible to admit of injury and therefore acceleration of the plant's death. But here it is to be noted that, if the unhealthy plant recover and flourish, no further increase in the number of nematodes takes place and they may largely abandon the plant. An interesting experiment was carried out to test the proof of this fact. A number of unhealthy plants in oat-sick soil were taken from the field and transplanted in normal fertile soil. Similar plants examined gave from 25-50 semi-parasites. In three weeks the plants recovered and developed healthy green leaves, and on examination from 8 to 20 nematodes were found per plant. This experiment, besides showing that the semi-parasitic nematodes infesting an unhealthy plant leave the plant on its recovery, proves that adverse soil conditions are the cause of oats failing on oat-sick soils. The abnormal numbers of semi-parasitic nematodes found in oat-sick-soil plants are, therefore, almost entirely secondary, and their presence cannot be considered as a factor in the cause of the plant's unhealthy condition.

Experiments on the treatment of Oat-sick Land.—In the reports 1911, 1912 and 1914 the probable cause of the oats failure is said to be the excess of lime or alkali in the soil brought about by the addition of shells and shell sand. I can find no details of any soil analysis to test this assumption. The fact that the soil contains many shells does not necessarily mean that it is over-limed. The proof of this latter statement is contained in the analysis of a typical oat-sick soil at England Farm, Portlethen, Kincardineshire. The field, bordering the cliffs, had been manured many years before with sea-weed, cockle shells and fisher dung, which was evident from the number of sea-shells lying on the surface of the soil. The soil is of a light porous nature and very well drained. One part of the field about one acre in extent grew typical oat-sick soil oats and here it was arranged to carry out some experiments.

The lime requirement and humus content of this particular soil together with three other normal soils are as follows :—

Locality.			Lime Requirement.		Humus Content.
			Percentage $CaCo_3$.	Cwt. per acre	
			Per cent	Cwt.	Per cent.
England Farm	(oat-sick soil)		0·03	6	10·80
Do.	(normal soil but bearing eelworm diseased oats)		0·13	26	12· 7
Little Haddo	do	do.	0·15	30	4· 7
Canterland	do.	do.	0·20	40	16· 2

From these results it is seen that the oat-sick soil instead of being over-limed, as reputed, has a lime requirement of 6 cwts. per acre.

In all the experiments carried out on oat-sick land the same two manures have been used, namely, sulphate of ammonia and superphosphate in the proportions of 1 cwt. and 3 cwt. respectively. These are typical acid manures and were employed for the purpose of reducing the alkalinity of the soil. In most cases good results were obtained, but the increase in crop might have been due to the nitrogen or the phosphate added in these manures.

To test the relative effect of the different manures seven plots, including two controls, area one sixtieth acre each, were laid out at England Farm and the following dressings applied :—

Sulphate of ammonia, 3 cwt. per acre.
Superphosphate, ,,
Potash salts, 30 per cent. ,,
Full manure { 1 cwt. sulphate of ammonia. 1 cwt. muriate of potash. 1 cwt. superphosphate. } 3 cwt. per acre.
Nitrate of soda, $1\frac{1}{2}$ cwt. after braird and $1\frac{1}{2}$ cwt. five weeks later.

The manures were broadcast by hand on April 7th and the

oats sown on all the plots on April 8th. Frequent visits were made to observe the progress of the plants' growth in the various plots. Little difference could be observed between the control and the manured plots until five to six weeks after germination. At the end of two months a decided contrast could be drawn. The plants in the sulphate of ammonia plot were vigorous and of a healthy colour; the control plots contained many unhealthy plants with withered leaves; the full-manure plot was not far behind the sulphate of ammonia plot; the superphosphate and potash plots were equal; the nitrate of soda plot, which received a first application of manure on May 15th, showed some improvement over the control plots.

During July and August the plots presented much the same degree of differences with the exception of the nitrate of soda plot. This plot fell back very quickly, which was not expected in view of the fact that it had made some improvement earlier. On the date decided for the second application not a healthy plant could be found and many of them were beginning to decay. It was considered useless to apply the second application of nitrate of soda.

As the plots showed the same degree of ripening, they were all cut on September 22nd and threshed some days afterwards. Nothing could be collected from the nitrate of soda and control plot I, as only a few straws could be found here and there. The yield of grain from the various plots is as follows :—

Plot.	*Yield in quarters per acre.*
Sulphate of ammonia	5·04 qrs.
Superphosphate	2·50 ,,
Control II	2·05 ,,
30 per cent. potash salts	2·00 ,,
Full manure	1·43 ,,
Control I	*Nil.*
Nitrate of soda	*Nil.*

In judging the samples of grain from each plot very little difference could be found. On the whole the best grain was obtained from the sulphate of ammonia plot, the seed being even in texture and quite well filled.

Discussion of Results.—The result of these investigations seems to indicate a possible explanation of the cause of oats failing on oat-sick soil, viz. the lack of readily available nitrogen.

The sulphate of ammonia plot proved successful, and the rate of growth of the plants was uniform throughout the growing season. The nitrate of soda plot improved after the first application of manure, but fell away very soon. These observations are interpreted as follows :—

When nitrate of soda is applied, the nitrogen is available to the plant immediately after application. The nitrogen in this case, however, is not fixed by the soil, but is readily washed down to the lower strata and lost to the plant. In the case of

sulphate of ammonia, the nitrogen in the form of ammonia is fixed by the soil and undergoes slow oxidation to nitrate, ensuring a continuous supply of nitrate to the plant during the growing season. Thus the nitrate of soda plot showed vigorous growth at first, but the plants died away as soon as the nitrate was washed down. The sulphate of ammonia plot, on the other hand, having an almost continuous supply of nitrogen, showed steady growth.

The full manure plot gave very poor results. The plot for a period of time had a healthy appearance, although the plants were very uneven in growth. The reason for the poor results was evidently due to an insufficient application of sulphate of ammonia.

The result of the superphosphate and potash plots shows that the plants received practically no benefit from the application of phosphate or potash. If the condition of oat-sick soil is due to excess alkali or lime in the soil, as formerly stated, one would have expected positive results in the case of the plot receiving an acid manure such as superphosphate.

While these experiments seem to indicate that oat-sick land suffers from lack of a continuous supply of available nitrogen and can be made to grow a profitable crop of oats by the addition of sulphate of ammonia alone, it is intended to repeat the experiments for the purpose of forming a definite conclusion.

Summary.—As a result of these investigations the following conclusions may be derived :—

1. The failure in the growth of oats sown on oat-sick soil is due to adverse soil conditions and improper nutrition, probably resulting from manuring the soil with cockle shells or fisher dung.

2. The belief that eelworms (*A. dipsaci*) are mostly present in oat-sick soils and are the cause of the failure of the oats is incorrect.

3. Oats develop normally and produce a profitable crop on oat-sick land, if nitrogen is applied at seeding in such a form that it is fixed by the soil, e.g. sulphate of ammonia.

My thanks are due to the late Dr. Rennie, Professor Hendrick and Mr. Moore, all of the North of Scotland College of Agriculture, for their helpful advice and criticism; to the late Mr. Newlands, Advisory Officer in Soils, North of Scotland College of Agriculture, who carried out the investigation of the lime requirements, and to Mr. Robertson, England Farm, Portlethen, who allowed me to conduct experiments on his farm. I am also indebted to the Carnegie Trust for a Research Scholarship which enabled this work to be carried out.

SOME POTATO-BREEDING PROBLEMS.

WILLIAM ROBB, N.D.A.,
Scottish Plant Breeding Station, Corstorphine.

THE disastrous effects of blight in 1846 spurred potato-breeders to greater efforts to produce improved potato varieties, and since that date many outstanding varieties have been introduced to commerce. Most of these, however, have declined in vigour after having had a greater or less vogue. This decline in vigour has always stimulated interest in potato-breeding, and the enthusiasm shown for this work by the early breeders has been successfully upheld by a varying number of enthusiasts from time to time. Continued hybridisation has played a large part in the breeding of new varieties of the potato, but the results obtained by this method are apparently largely a matter of chance and they are very often unsatisfactory. The consequences of continued hybridisation in potato-breeding are clearly indicated by Jones (1), who states with reference to potatoes, &c., that :—"For every individual of promise thousands of plants must be grown and destroyed. All vegetatively propagated varieties, after countless generations of crossing and re-crossing, are genetically so complex that attempting to obtain further improvement by repeated crossing is like solving a picture puzzle in the dark."

Before referring to a few of the results of the potato-breeding experiments at the Scottish Plant-Breeding Station and to the conclusions drawn from them, mention may be made of two obstacles encountered in carrying out experiments in potato-breeding. One is universal, the other is more or less local. The first obstacle is the difficulty, and in some cases the impossibility, of getting certain varieties to function as parents. A number of varieties of the potato can be used quite readily either as male or female parents, e.g. Flourball; a few varieties which can function as female parents possess characteristics which render them unable to function as male parents, e.g. Up-to-date; certain varieties may be successfully utilised as female parents only in favourable seasons, e.g. Great Scot; several other varieties seldom function naturally as parents, e.g. King Edward.

The second obstacle is the difficulty of maintaining healthy plants, due, at Corstorphine, to the prevalence of virus diseases. It was found that the virus diseases, leaf-roll and mosaic, spread among seedling potatoes apparently much more rapidly than was experienced at St. Andrews, Fife, where the writer was engaged in potato-breeding experiments some years ago. Many named varieties also have quickly lost vigour at the Plant-Breeding Station through infection with these virus diseases. Some of the strains or families of seedlings were apparently more readily infected than others, but sooner or later loss of vigour through virus disease set in, and it has been impossible to maintain a stock of healthy plants for successive trials. Since 1926 the seedling potatoes for the Station have been raised in a district where the environmental conditions are different from those at

Corstorphine, and the results obtained so far, indicate that less difficulty in maintaining healthy plants will be experienced there than was the case at Corstorphine.

An endeavour was made to overcome the limitation imposed by varieties which shed their flowers prematurely. Plants of the King Edward variety were used as female parents in the investigation. The methods employed were (*a*) early and repeated application of viable pollen to the stigmas; (*b*) grafting of flowering shoots of the potato on tomato plants in order to prevent the potato from forming underground tubers and thereby possibly stimulating free flowering. Neither of the above methods, however, gave positive results.

In referring in this article to the breeding experiments at Corstorphine, notes concerning only two hybrid progenies will be given, but they will suffice to illustrate results met with probably all too frequently in potato-breeding, viz. the high proportion of plants less desirable as agricultural types than their parents.

Up-to-date X Majestic.—From this hybrid over 250 seeds were secured from one berry; 87 per cent. of the seeds germinated and 208 plants survived. These were all planted out, and were grown under conditions as uniform as possible. There was a wide range of foliage types, some tall and vigorous, several dwarf and weakly, and others varying between these two extremes. The yield and the number of tubers from matured plants also varied widely. All the tubers in the progeny were white-skinned; in shape they varied from " round " to " long kidney." Eighty-two plants had comparatively long underground stems or stolons, and they were thus of an undesirable type. The stoloniferous plants generally produced a low yield of small tubers. Seventy-seven per cent. of the plants were susceptible to wart disease—a high percentage of seedlings which on economic grounds could be discarded at once.

The seedling progeny were decidedly inferior to either of the parents as regards habit of growth, cropping power, shape, and the average size of tubers. Frequently the higher-yielding selections contained numerous tubers, but too many of these were small.

Golden Wonder X Glassel Beauty.—This family of seedlings is of interest in serving to indicate the number of types which may be obtained from a hybrid berry. Golden Wonder, as is well known, has kidney-shaped, russet-skinned tubers; Glassel Beauty has round, red tubers. From 200 seeds of one berry, 190 seedling plants were obtained. These were planted out and 136 plants matured. Amongst these were 73 seedling plants bearing coloured and part-coloured tubers and 63 plants bearing white tubers. The group of plants bearing coloured tubers showed a series of gradations in tuber colour, ranging from bluish-purple to faint pink. The tubers on most plants were decidedly unattractive, and none of the selections was deemed worthy of extended trial.

It may be stated here that in view of Golden Wonder possessing certain desirable qualities, many hybrid seedlings raised from Golden Wonder as female parent have come under the writer's observation for selection of promising plants, but they have almost invariably been undesirable types, and no plant of sufficient merit for extended trial has been observed. It is perhaps also worthy of note that no russet-skinned tubers typical of Golden Wonder have been seen in any of the hybrid or selfed progenies of Golden Wonder raised at the Plant Breeding Station, or in those raised by the late Dr. John H. Wilson at St. Andrews, Fife.

Other Crosses.—Over 1,000 seedlings have been raised annually at the Plant Breeding Station, Corstorphine, from 1921 until 1925, and amongst the progenies raised there have been several promising selections, which, so long as they remained healthy, reached a high standard of excellence. Some of these compared very favourably with standard named varieties, but even in the progenies containing promising selections a large proportion of the plants was much below the standard of the best cultivated varieties.

It may be of interest to the reader if we refer here very briefly to the work of a few other potato breeders.

Stuart (2), of the U.S.A. Department of Agriculture, stated in 1921 that :—" Since 1910 the U.S. Department of Agriculture has, with two exceptions, grown several thousand potato seedlings each year. The largest number grown in any one season was in 1910, when over 28,000 potted seedling plants were transplanted into the open field." He also indicated in 1921 that while the Department had a number of promising seedlings, they had not at that time introduced any highly disease-resistant meritorious commercial variety.

In the report of a lecture given by M'Kelvie (3), one of the most successful raisers of new varieties of potatoes, it is stated that of 3,000 seedlings raised by him in 1922 only two were retained for further trial in 1927.

Anderson (4) states in connection with potato breeding that " generally speaking, 90 per cent. of seedlings can be discarded at sight."

The results obtained at the Plant Breeding Station probably agree more or less with those obtained by other potato breeders, and support the opinion that success in creating new and improved varieties, by repeated crossing of cultivated varieties of the potato as presently constituted hereditarily, depends largely on chance.

The writer has found that in the seedling progenies of many cultivated varieties the types of plants most desired, i.e. those approaching the standard of excellence of cultivated varieties, occurred infrequently in some crosses and never at all in others. To make further progress in potato-breeding methods it is of first importance to try to reduce the chances of the undesirable or inferior types occurring. If this can be accomplished, and it

seems possible that it will, much expenditure of time and effort will be saved, and thus a higher rate of progress than is possible at present will be attained.

One of the problems, therefore, is : how to obtain better control of the various factors which determine the inherent capacity or hereditary constitution of any type or variety. In considering the problem it is necessary to look upon the mature plant as the outcome of the reaction between the hereditary elements within the plant and the plant's environment.

It must be understood that the hereditary factors will be expressed to the highest degree only when they react with an environment suitable to their full expression. In comparison with the effects of environment, it is generally held that the hereditary capacity is indelibly imprinted on the organism, but while the hereditary factors of a plant may be regarded as relatively stable under normal conditions, the degree to which some of them are expressed in the matured plant may fluctuate within limits. In general it may be said that, if the hereditary capacity is such as to produce an undesirable type of plant, then it may be concluded that, no matter how favourable the environment is, the type of plant will not advance beyond its inherited capacity.

The complexity of the hereditary nature of potatoes has been indicated, and it is rendered evident by a progeny consisting of many different types resulting from a plant that has been fertilised by its own pollen. If the general principles of the Mendelian theory of heredity are accepted—and a large number of experiments in breeding fit in with this theory—the simplification of the hereditary constitution of potatoes should be brought about by resorting to self-fertilisation and inbreeding with a view to obtaining as many different types of potato plants as possible, which will breed relatively true to type through the seed. By selfing and inbreeding many hidden hereditary characters will be brought to light; the favourable ones may be retained and the unfavourable ones eliminated. By eliminating the unfavourable hereditary elements the chances of undesirable types of plants being produced will be lessened, and not only that, but it is possible that some of the hereditary factors may be more fully expressed when they are not associated with interacting unfavourable factors. Selfing has already been applied to other crop plants. We understand that it has been successfully applied to maize in the U.S.A. as a means of obtaining improved parental strains. One of the immediate results following inbreeding of maize was loss of vigour in the inbred strains. This loss of vigour did not of itself impose any serious difficulty, for vigorous strains giving a higher yield than the original varieties were again obtained by resorting to crossing inbred or selfed strains whose genetic constitution was known, at least as regards the more important characteristics of economic value which they transmitted. The same procedure might well be followed in potato-breeding.

There is reason to believe that, unlike maize, certain strains of sunflower became extremely uniform by inbreeding without losing their vigour. Apparently it was possible to combine in an inbred strain of sunflower more desirable growth factors than were possessed by the average open fertilised populations.

In connection with selfing it may be stated that in the experiments at the Scottish Plant Breeding Station, selfing of certain plants is being carried out in what promises to be a tolerably healthy environment, and the results obtained so far encourage the hope that fruitful results will ultimately follow.

The value of self-fertilisation and inbreeding is implied in the quotation from Jones given at the beginning of this paper. Other writers have also recommended self-fertilisation. Krantz found selection in self-fertilised lines of potatoes to be a practical method of securing improved parental material, and he was thus led to the conclusion that selection within self-fertilised lines, with subsequent crossing of the inbred plants, was the most promising and the most practical method for the further improvement of potato varieties.

Muller (5), advises the breeder of early-ripening varieties of potatoes to use, for cross-breeding purposes, early-ripening varieties which are capable of reproduction, and in all cases only after a preliminary testing of the parent plants through rearing of young plants grown from selfed seed. The same writer points out the desirability of growing on to the second generation, when a wider range of variability may be found than in the first generation.

Salaman (6), has successfully accomplished much work on the mode of inheritance of a number of characters in the potato plant, and has demonstrated that various characters are inherited on Mendelian lines. One finds, however, that he has little hope of the practical application of the Mendelian principles of inheritance to potato breeding, unless the experimenter possesses " the eye of the fancier, the *flair* of the breeder." We hesitate to accept the view that :—" To select the right seedling is both more important and more difficult than to know how to breed it." If it were known how to breed an immune " Epicure " or an immune " British Queen " potato for instance, it does not seem that the selecting of them afterwards should present great difficulty, provided all the seedling progeny plants are grown under environmental conditions suitable to the full expression of all the hereditary factors. In selecting, as distinct from breeding, the personal equation no doubt plays an important part, but it is quite possible that the selector may be either considerably aided or handicapped in his efforts by the effects of the environment in which the plants are grown.

In considering the influence of environment one must realise that it functions both externally and internally, but that it is not possible to distinguish sharply the points where external and

internal environments operate. Different plants of a species may react differently to varied environments and show different ranges of adaptability. That is to say there may be a greater or less range between the best and the worst environmental conditions for different plants. In potatoes this range no doubt varies with the variety, but on the whole it is fairly wide. From the results obtained during several years of raising potatoes from the seed or b rry to obtain data with reference to the hereditary capacities of different parent plants the question arises whether growing plants under environmental conditions tending towards the best, towards the mean, or towards the worst will best differentiate the hereditary types. While the writer has no definite proof, experience in raising seedling potatoes in two different districts with different environmental conditions suggests that the more favourable these are, the more advantageous it will be for the breeder, because by getting a fuller expression of the various hereditary factors of the plants the breeder will be able to distinguish more easily the different hereditary types. The environmental conditions, if poor, may operate to obscure some of the hereditary elements of a plant and hide its real identity.

Little is known of the effect on mature plants grown from seed of the particular agencies permeating either the female parent plant while it is setting seed or the seedling potatoes. These problems require investigation and their solution would greatly assist potato breeders. Is it possible that particular environmental conditions may impart to a seedling something in the nature of a temporary stimulus to its vital functions?

Ward Cutler (7) has indicated that part of the living matter of a plant, i.e. the cytoplasm, may possibly play a part in the occurrence of certain pathological conditions in plants. This possibility is of interest to the potato breeder in connection with the occurrence of virus diseases in seedling potatoes. Results obtained with seedling potatoes at the Scottish Plant-Breeding Station at least indicate, if they do not prove, that these diseases or "degenerate" conditions are borne by or are in some way transmitted through the seed, and suggest that breeding from uninfected plants in a relatively healthy environment may be a helpful, if not an essential, condition for the carrying out of certain potato-breeding experiments.

In making reference to the question of the effects of different agencies permeating the living matter of plants it may be pertinent to refer to the results of several workers who have recently been investigating problems arising out of the occurrence of virus diseases in potato plants. There appear to be two opposite views of the nature of the virus disease, leaf-roll. One, that it is brought about by a predisposition in the plant to become upset—perhaps chemically, in its vital functions; the other, that it is an infectious disease caused by an ultra-microscopic organism. Schander has expressed the opinion that leaf-roll is brought about through the upsetting of the chemical equilibrium of the living

cell, and that the plant in question must, to a large extent, be prone to this condition. This opinion presents a new aspect from which the problem of preventing "degeneration" in potatoes may be approached.

The assertion is occasionally heard that virus diseases are more prevalent to-day than they were half a century ago. If this be so, it may be inferred, in view of Schander's opinion, that some of the present day potato varieties have been bred from varieties possessing this predisposition to become upset in their vital functions. Schweizer (8), in giving an account of experiments he carried out in Germany on potato-plants affected with leaf-roll, has reported that he introduced various chemical solutions into the tissues of leaf-roll plants, and that with a solution of albumen and pepsin he obtained positive results. After a few days' treatment the curled leaves again performed their normal functions. The new leaves formed thereafter were of a dark-green colour, and the effect of introducing the above-mentioned substances was permanent throughout the growing period. Calcium nitrate, on the other hand, while it appeared to arrest the development of leaf-roll, had no effect on the already rolled leaves.

In this brief survey of a few potato-breeding problems an endeavour has been made to indicate the complexity of some of them, and the importance of utilising all the knowledge available concerning both heredity and environment in relation to the potato. The position may be summarised as follows :—

Choice of varieties for parents is limited by abnormalities occurring in the floral organs of a number of varieties.

The hereditary constitution of many, if not all, of the cultivated varieties of the potato is probably complex. Variable proportions of the progenies of hybrids from many potato varieties of a high-standard of merit are often relatively worthless.

Success in creating new potato varieties of agricultural value by crossing cultivated varieties that are complex in their hereditary capacities depends largely on chance, and entails a large expenditure of time and effort, with no commensurate progress in the acquisition of additional knowledge of the hereditary constitution of potatoes or in the development of improved methods of breeding. Success in selecting new and improved varieties of agricultural importance may be increased or diminished within limits through the effects on the seedlings, of the environmental conditions under which the plants are grown.

Little is known regarding the relative effects of raising seedling potatoes under different environmental conditions.

With a view to making further progress in potato-breeding methods, more information is required concerning the controlling agencies and their interaction, in the genesis of different varieties of the potato. This information should in theory be most readily obtained by selfing and inbreeding different types of potatoes. Breeding on this system is in conformity with the generally accepted principles of heredity. While pure-breeding

plants may not of themselves be directly of economic importance, they should be of much value for experimentation.

REFERENCES.

1. Jones, Donald Forsha.—*Genetics in Plant and Animal Improvement.* 1925.
2. Stuart, W.—"Potato Breeding, Selection and Seed Development Work in the United States." *Report of the International Potato Conference*, 1921.
3. M'Kelvie, D.—"Potato-Raising Problems." Report of Lecture in the *North British Agriculturist*, 10th November 1927.
4. Anderson, T.—"Plant-Breeding." *Transactions of the Highland and Agricultural Society of Scotland*, vol. xxxiii, 1921.
5. Muller, K. — "Untersuchungen zur Genetik der Kartoffel." Extract in *Zeitschrift für Pflanzenzüchtung*, Band 12, Heft 4. 1927.
6. Salaman, R. N.—*Potato Varieties.* Cambridge, 1926.
7. Cutler, D. Ward.—*Evolution, Heredity and Variation.* 1925.
8. Schweizer, Gg.—"Zur Blattrollkrankheit der Kartoffelpflanze." *Berichte der Deutschen Botanischen Gesellschaft*, Band xliv, Heft 9. 1926.

THE BIOLOGIST on the FARM.—No. XXXII.

Professor J. ARTHUR THOMSON, M.A., LL.D.,
University of Aberdeen.

The Winter Picture.—The innermost fact in the Biology of Winter is the periodic rest and retrenchment, partly in adaptation to the difficult seasonal conditions and partly because vigorous life tends to be more successful when it is punctuated. In a warm country, such as British Guiana, the seasons are gently marked as compared with those in the British Isles; and in spite of much obvious activity the tide of life does not rise so high as it does with us. A winter's rest helps towards a summer's industry. We mean that apart from the snows and frost and storms, by which living creatures are forced to lie low, there are constitutional reasons for a period of repose.

Thus the winter period includes the somnolence of the trees in most of which there is but little doing; the quiescence of the buds formed in the abundance of last summer and now well-wrapped up in non-conducting scales; the shifting of the wealth of many plants from above-ground parts to root-stock and root, tuber and corm and bulb, often well-sheltered from the frost which would burst the cells; and the faint flickering of life in the multitudinous seeds that are deeply sown in the earth. The fact that some of these seeds, like the young stages of some insects, normally lie quiescent for more than one winter, shows that there are internal as well as external reasons for the periodic rest.

Similarly among animals there is a long inclined plane of repose. Some mammals, like the badger, doze the days away, though they cannot be called "winter-sleepers"; others, imperfectly warm-blooded, like the hedgehog and the marmot, illustrate the remarkable constitutional relapse called true hibernation; then there are various stages of lethargy and coma as in the queen humble-bee in the mossy bank, the snails in the

recesses of the wall, the frogs in the dry drain, and the slow-worms in a hole on a well-sunned hillock on the moor. We are still far from being able to arrange the various forms of "suspended animation" in physiological order; but that will come. A number of aquatic animals, both in fresh water and in shore pools, show very marked bodily retrenchment. Thus the fresh-water sponge dies away except as regards its pinhead-like gemmules, which float off from the dead parent body and start new sponges in spring. Thus, again, many of the zoophytes or hydroids in the shore-waters die down to a greater or less extent on the approach of winter, illustrating what may be called the policy of reducing the surface of vulnerability, just as trees do in shedding their leaves.

Another adaptation is some change of habitat, some retreat before the enemy, such as the cold and scarcity. The earth-worms may burrow more deeply before the clutching of the frost's fingers; the mountain hare and the ptarmigan may descend to lower altitudes when the snow is very deep on the heights; most of the birds have escaped to the south.

Ptarmigan and mountain hare illustrate another fitness in assuming white plumage and white pelage on the approach of winter. The new feathers and the new hairs are developed without pigment, but with numerous minute gas-vacuoles whose mirroring surfaces reflect the whole of the light and thus produce what we call whiteness. Sometimes the white dress serves as a cloak of invisibility, but the other day on an exposed brown stretch of one of the Cairngorms we saw a mountain hare challenging attention most conspicuously, a white target for any golden eagle! So that we must re-emphasise the deeper utility that, for a warm-blooded animal in very cold surroundings, a white dress loses less of the precious animal heat than a dress of any other colour.

Perhaps the hardest life lived in Europe is that of the mountain vole or snow mouse, which rarely descends below 4,000 feet. It was originally a Northern Tundra animal that came south in interglacial ages, but has disappeared except from the lofty mountains. It tunnels beneath the snow from one Alpine plant to another, and it is helped to survive the winter by its stores of gentian roots. For we must not leave out of our picture the stores that many animals make in days of plenty, that serve them well when the wolf of winter is at the door. And the stores need not be external, they may consist of fat and other reserves laid up in the recesses of the body itself. Thus there is a long slab of tallowy fat from the root of the reindeer's neck to above the rump, where it is several inches thick.

Winter Visitors.—Everyone knows that the birds of a North Temperate country may be arranged in five groups according to their standing as visitors, tourists, or residents. (1) There are the ever-welcome summer visitors, such as swallow and swift, cuckoo and nightingale, wheatear and corncrake, who nest in

Britain and migrate at the end of summer to more genial lands. (2) Then there are the partial migrants, say lapwings and goldfinches, which are never unrepresented in Britain, though some go and others stay when winter comes. (3) A small group includes the true birds of passage, such as some of the sandpipers, which rest on our shores for a short time on their way further north in spring or further south in autumn. North Temperate migratory birds always nest in the colder part of their migrational range. (4) Then there are the residents who do not migrate at all or not for any noteworthy distance. This list is much shorter than is usually supposed, for many apparent residents are partial migrants. As representative residents we may name red grouse, house sparrows, water hen, and golden eagle. (5) The fifth group, which we cannot but think of at this season, includes the winter visitors that nest further north and find shelter in Britain for the winter, such as the Iceland gull, the glaucous gull, the wild swans, the wild geese (except the grey lag, which sometimes nests here), the miscalled Bohemian waxwing, which nests in circumpolar regions, and the interesting turnstone that tips stones upside down on the wintry shore for the sake of the small creatures that have been sheltering underneath.

Twenty miles or more from the sea we sometimes find an exhausted or battered Little Auk, a characteristic winter visitor, though its search for shelter in Britain is often fatal. It is a dark-coloured white-breasted bird about eight inches long, with a stout conical beak. It is a relative of the extinct Great Auk and a very attractive little bird. It breeds on the Arctic Islands, but spends much of the year on the open sea, spreading in winter as far south as the Azores. A strong swimmer and diver, it feeds chiefly on open-sea crustaceans and the like, and it lives on the whole a successful life. The greatest risk it has to run is the prolongation of cold and stormy weather over many days, for this drives the Plankton animals, on which many sea-birds depend, to quiet depths where they cannot be readily captured. Then the Little Auks are starved and lose their powers of resistance. They take to wing, flying swiftly in straight lines, and are apt to get battered against the cliffs. Those that lose their bearings and fly confusedly inland stun themselves by colliding with trees and telegraph wires or other unfamiliar obstacles. Thus there is sometimes a sad wreckage of these attractive winter visitors.

The most magnificent of our winter visitors is the Great Northern Diver or Loon, a bird "as big as a goose." Very handsome it is in its black and white plumage; very masterly in its swimming and diving. It can stay three minutes under water, which is a long time to do without a breath. It is said that the Great Northern Diver cannot rise directly from the ground, and it certainly makes a great spluttering in launching itself out of the water. Its body is heavy, and the bird sits in the sea like a heavily-laden ship. Somewhat mysterious is the way in which it can slowly sink itself until the waves are awash

over its back. The Loon has a resonant distressful wail, which is said to gain a melody of its own at the breeding season in the Far North. For like other winter visitors this noble bird nests in more or less Arctic regions, the nearest breeding place being in Iceland.

We cannot say this of the snow buntings, for they sometimes breed on Ben Wyvis and other such places; yet it would be rather pedantic to exclude them from the winter list. They come late in the year in little flocks from across the North Sea, singing or twittering as they fly, often appearing suddenly in the mirky air. As there is much white in the winter plumage, the popular name of snow-flakes is well deserved. They usually arrive in very good condition and settle down on the fields to search for seeds. In summer they are chiefly insect eaters. They are nearly related to corn-buntings and yellowhammers.

Also to be included among the winter visitors are some of the wild ducks, like the golden-eye and the velvet scoters, which are familiar on the estuarine waters. The most striking of all winter flights is that of the Arctic tern, which may winter in the Antarctic as far south as 74°. This is the maximum migrational range.

The Pruning Hooks of Winter.—Those who try to garden ambitiously in exposed parts of the country are familiar with the tragedy that some of the herbaceous plants are always disappearing. They delighted us in 1928, but in 1929 they will be conspicuous by their absence. They have been eliminated by the winter. This is but a reminder of what happened on a large scale during the four successive Pleistocene Ice Ages—ages of horror when the greater part of the British fauna was wiped out for the time being. Except a tract to the south, now represented by the southern counties of England, the country was covered by glaciers. In the interglacial periods many of the animals crept back again as the ice melted in the valleys, but they had to retrace their steps or perish in the winters, or when the next Ice Age set in. When the climate changed definitely for the better and the glaciers disappeared, there was a great re-colonisation of the British peninsula from the continent, and this continued until Britain became an island and the door was shut to further pedestrian immigrants. During the re-colonisation almost all our present mammals got a footing, except such modern aliens as the two rats; but there were some of the old residenters like the cave lion, the cave bear, the mammoth and the woolly rhinoceros that never returned at all. Moreover, since the insulation we have lost not a few very interesting mammals that shared in the re-colonisation, such as the reindeer, the wolf, and the beaver. Our point is that we should look at our winters, with their continued elimination, as echoes or reverberations of the Ice Ages when the whole fauna shuddered. We have known of a big barrowful of birds being gathered in a stackyard after a night of severe frost, and it should be remembered that one night of very low temperature may do more pruning than weeks

of what must be called very cold weather. The wreckage of the Little Auks that we spoke of above is but an instance of the way in which the pruning-hooks of winter may work, but it is of little moment since there are such enormous numbers of these little birds in the Arctic Ocean. The pruning is of course most marked among resident birds and mammals, and there is a widespread impression in Scotland that some of our common birds, such as yellowhammers and chaffinches, are becoming rapidly scarcer, partly because the modern roads afford much less in the way of food than they used to do when horses were more in evidence and the surface was less repellent to birds.

But there is another aspect of the winter's elimination which the farmer gratefully recognises, namely the killing off of large numbers of grubs and other soil-animals that are injurious to his crops. Especially when frost follows ploughing there must be an elimination of these pests on a large scale, and this is all to the good. The winter is for us as well as against us!

The Conquest of Distemper.—Another fine instance of the biological control of life is the discovery which Messrs. G. W. Dunkin and P. P. Laidlaw have made that the dog-distemper can be baulked by a vaccine treatment. The troublesome and costly disease has been a shadow for many a year, but man seems to have conquered it at last. For a long time it has been recognised that distemper is a microbic disease, somewhat analogous to measles and scarlatina in children. While predominantly catarrhal, affecting the lining of the nasal passage, it may spread to the lungs and the food canal, the liver and the nervous system. It is particularly common in puppies between four and eleven months, but increasing age gives no complete protection. An attack in early life usually confers immunity if the animal survives, but this is by no means absolute. The usual general treatment in the past has been to administer internal disinfectants and to try to keep up the patient's strength, though by means of very light food.

One of the reasons why distemper has baffled investigators for so long is that the disease often occurs in conjunction with other microbes besides the specific one. In other words, there may be a mixed infection. The second reason is that the distemper microbe is much smaller than an average bacillus. It belongs to the elusive series of "filter-passers" or filterable viruses, including, for instance, the causes of smallpox, rabies, foot-and-mouth disease, and, according to some authorities, measles and scarlet fever. There are also many plant diseases that are due to filterable viruses.

Two years ago Dunkin and Laidlaw showed that a pure form of distemper could be produced in ferrets infected from dogs. It can be transmitted from dog to ferret, from ferret to ferret, from ferret to dog, by material in which no bacteria can be demonstrated. In their further experiments at the Medical Research Council Farm Laboratories at Mill Hill, the investigators have prepared from infected ferrets a vaccine that will

immunise either ferrets or dogs. A convenient form of the vaccine is a formaldehyde extract of the infected ferret's spleen, and a large dose of this non-living vaccine will induce immunity in about 90 per cent. of the ferrets into which it is injected. But to consolidate the immunity thus induced it is necessary to administer living virus. It is probable that what is brought about in the dog or the ferret is some general change in the cells of the body and not the production of some specific anti-body or counteractive in the blood. The triumph is that dogs may be rendered immune to a common and vexatious disease, and that a single dose may be enough. A dog first treated with the formalised extract from the tissue of a distemper dog, and subsequently with living virus, appears to have acquired solid long-lasting immunity, firm against other strains of dog-distemper. The investigators deserve the heartiest congratulation. The next step is the large-scale production of the immunising vaccine, but that, though requiring meticulous carefulness, is not a task for investigators.

Marco Polo's Sheep.—Our domestic sheep, whose potentialities we get a glimpse of in the adventurous lambs, suffers individual degeneration as the nemesis of an over-sheltered life. It gets plenty to eat without much exertion beyond industrious browsing and mastication, and it is safe from enemies except when dogs start worrying. Perhaps, though the lambs do not suggest this, it also suffers from centuries of domestication during which man has removed all the individuals that persisted in being adventurous and original. Even the ewes themselves seem to frown on their offspring when these continue too long in their early experimenting mood.

To get a just impression of what a sheep may be, we must consider Marco Polo's sheep, recently described afresh by Mr. William J. Morden, field associate of the American Museum of Natural History. We select a few points. The fine sheep, *Ovis poli,* lives on "the roof of the world," on the High Pamirs in Turkestan. Like the hardy yaks they ascend over ten thousand feet, and are abundant in their fastnesses. They are famous for their massive horns, which may be 57½ inches long around the spiral, with a spread of 41 inches. Very wary and extraordinarily strong, Polo's sheep are seldom seen at close quarters. It would be impossible to hunt them without the patient, indefatigable yaks. Though the spiral horns are heavy in both sexes, the skeleton as a whole is lightly built and brittle, and the body is wiry rather than massive. A ram may weigh 239 lbs., but there is very little fat. The winter pelage is heavy, white and brown in colour with an intermediate grey. The horns are yellow-white like old ivory. The summer coat is short. In the spring the rams keep by themselves; the ewes and yearlings congregate in large herds. Polo's sheep are accustomed to spartan diet, such as is afforded by wire-leaved grass and wild onions. Yet they thrive and hold their own. On a short exploration Messrs. Morden and Clark counted over a thousand rams and six hundred ewes.

The Golden Bough.—In some parts of Britain there is a considerable trade in mistletoe, and it seems a pity that we should import any. For it grows well, is very beautiful, and can be kept easily within bounds. It is biologically interesting in many ways, first, because it flowers and fruits in the hard months of the year, the simplified blossoms being visited by winter-flies; secondly, because it is descended from ancestors which rooted in the ground, while all the typical kinds are now perched plants, never touching earth; third, because it is sown by the missel-thrush, which either wipes the "limed" seed off its bill on to a branch, or passes it through its food-canal and voids it on a similar position; and fourth, because it is only a parasite to the extent of using the apple-tree as a system of pipes for conveying the soil-water to the branches. The evergreen leaves manufacture sugar and other carbon compounds just as all ordinary green plants do. The mistletoe is the golden bough that has figured so much in folk-lore, for when grown on an oak (its rarest support) it wards away evil and danger and brings happiness and wealth. To hang it up in a room is to recognise that the gods are all powerful, and then things can be done under the mistletoe which would elsewhere be sure to make the unseen powers jealous! But quite different is the Scandinavian story in which the mistletoe typifies the deadly power of the winter. It alone, fashioned into a piercing arrow, was able to kill Balder the Beautiful, the emblem of our fair earth in its summer vigour.

A SURVEY OF DAIRY FARMING IN ABERDEENSHIRE.

ALBERT D. IMPER, B.Sc. (Agr.), M.S. (Econ.), Ph.D., N.D.A.,

North of Scotland College of Agriculture.

In order to procure some definite information on the organisation and management of dairy farms in the area supplying milk to the City of Aberdeen, an agricultural survey of such farms was carried out in 1927.

The method employed was to visit approximately a hundred farms of all sizes and types where the major enterprise was milk production. A balance-sheet and a profit and loss account were drawn up for each farm, depreciation being allowed at the rate of 5 per cent. on all permanent equipment and working stock with the exception of tractors and engines, which were depreciated at a higher rate.

The results of the enquiry are based on the averages of class groups. It was found that the farms could be conveniently grouped into four classes each with 15 or a multiple of 15 cows. There was direct correlation between cow population, acreage, and live stock units carried, but as dairying was in every case

the chief interest, grouping according to cow population was adopted.

The farms were found to be scattered around the city up to a radius of about 15 miles, although there were a few at a greater distance. The average distance of those visited was from Aberdeen 8·9 miles, and from the nearest railway station 2·8 miles. They were not specially grouped, but were found scattered amongst other types of farms. Proximity to a railway did not appear to have any bearing on the type of farming, but there were indications that to be close to a good road was of very great importance to the dairy farmer, as all the milk was collected by road transport and the bulk of foodstuffs and manures delivered by the same means.

The soil was reported as being mainly of a medium loam, but clay and peat were also encountered in the lower parts of the valleys. The area, being undulating, varied in exposure and in productivity.

General Organisation of the Farms.—*Cropping.*—The usual rotation was the six course; this included two white crops, one green crop, and three years grass; usually about half of the new grass was cut for hay. One or two instances of five and seven year shifts were found, the difference usually being due to decreasing or increasing the pasture by one year.

The main grain crop was oats, and thick-skinned varieties were the most common. The most widely grown was Victory Oats, which covered 40·1 per cent. of the oats acreage; Castleton Potato Oats were grown on 26·4 per cent., Giant Eliza on 19 per cent., and Ascot, King, Crown, Superb, Abundance, Propsteier and Black Oats on the remaining 14·5 per cent. of the acreage.

Average Yield and Amount of Oats Sold per Average Farm.[1]

Group.	*Average Size of Farm.*	*Average Yield.*	*Percentage Sold.*
	Acres.	Qrs.	
1 ...	43·8	5·8	31·4
2 ...	119·0	6·2	39·2
3 ...	204·6	7·3	46·6
4 ...	404·9	7·3	44·0

The individual records show many variations in the yields, but the above table shows the averages for the class groups. It is noticeable that on the smaller farms the average yields are less than on the larger farms. Many of the smaller farms are on the lower parts of the valleys and have peaty soils; on such land it was usual to find that Castleton Potato Oats were grown and that the yields were decidedly low; on the other hand, heavy-yielding varieties such as Giant Eliza and Victory were usually grown on the larger farms.

The proportion of the crop sold varies from farm to farm, but on practically all farms there is a certain proportion which

[1] cf. "Small Holdings," Ruston, *Transactions of the Highland and Agricultural Society*, vol. 38, 1926.

is sold as market grain, although a few farmers attempt to market all grain through live stock and in this way reduce food bills.

Barley is mainly of the "Common" variety, and practically all this crop is sold either direct to distillers or to merchants. Grain for seed is usually saved from the preceding year, but a change of seed is commonly made every two or three years. This seed is sometimes exchanged but more frequently purchased through merchants.

Turnips are the main root crop, as farmers find that they form a better feed for dairy cows than swedes, of which only a few acres per farm are grown. Silage is made on a few of the larger farms.

Grass was usually of a good class, and practically all farmers included in their seeds mixture a small quantity of wild white clover.

The use of artificial manures is very extensive throughout the area, and it is usual to find that compound manures are used. There is in the area a society, one function of which is to analyse the manures being sold and to acquaint the members with the results of the analysis and the relative values. In this way poor fertilisers are detected, and farmers have found from experience that local merchants have consistently sold manures of good quality, so that little home mixing is practised. The use of wild white clover is reported to have greatly reduced the amounts of manures used.

Lime is very little used in the area, although many farmers are of the opinion that it is required, and from the appearances of the weed flora one would gather that some of the soil is of a sour kind and might well respond to liming.

Stocking.—There was no uniform system of stocking found in the area, but many farmers practised similar methods. The dairy herds were mainly composed of cross Shorthorn cows, termed locally "Irish" and "English." Several herds of cross Friesian and a few herds of pedigree Friesian were also found.

The management of the dairy herds was complicated by the prevalence of contagious abortion, which has given rise to two entirely different systems. The first, and by far the more common, is to treat this disease as a matter of luck and to take no steps to decrease the toll which it took; the second, practised by all the pedigree herd owners and a very few others, is to get an abortion-free herd and breed up the cows, so that there is no purchasing of cows which may infect the whole herd. Any animals brought into the herd, such as a new stock bull, would be from a herd which is known to be clear. This, of course, entails the usual period of inoculation with the necessary outlay in veterinary expenses, but those farmers who have adopted this method declare that the results have fully justified the expenditure. No detailed figures regarding costs could be obtained, but when the losses of calves and decrease of

milk flow are considered it would appear certain that the scheme is economically sound. In several cases the disease was so prevalent that the farmers had ceased to breed from their herd, and consequently were obliged to replace practically all their cows every year. When one considers that the purchase price of cows averaged £30 and the sale price only £18, it is evident that the loss over the herd was considerable.

The replacement of the dairy herd was a considerable item, and from the figures obtained over the 91 farms, for which satisfactory results were received, with a total cow population of 2,473 cows, it was found that 1,023 cows were replaced per annum. This corresponds to 41·4 per cent. of the total cow stock. Under the two systems mentioned above, the herds which were replaced by purchase comprised 1,881 cows, of which 885 were replaced annually, a percentage of 47 per cent., while in those herds replaced by home-bred stock 592 cows were kept and 138 replaced yearly, or only 23·3 per cent. of the total number of cows carried.

The milk yield per cow year varied very little from group to group and averaged about 779 gallons. This figure does not represent the production of one cow, but one cow year. The many changes brought about by cows aborting and the subsequent falling off of the milk yield cause more than one cow to be used throughout the year.

The farmers have usually contracted to the full producing capacity of their farms, and consequently cannot carry over any cows which abort. On the smallest farms they have not sufficient acreage to do other than purchase as required, so that they are faced with two alternatives. The first is to decrease their contract and keep a disease-free herd, thus cutting their losses due to changing cows frequently; or, secondly, to produce to their fullest capacity and risk the losses from the disease. It was impossible to obtain data on which any decision as to the relative financial advantages of those two alternatives could be based, but from an analysis of the figures obtained it would appear that, at least on farms of a moderate size, say carrying over 20 cows, the disease-free herd would be the more economic.

In very few cases were dairy stock the only class of productive stock carried, but no general plan of stocking was in operation. The usual procedure was to keep an Aberdeen-Angus bull and to sell the calves a few days after birth.

Several minor stock enterprises were found and may be considered under a few general headings.

(a) *Cattle Feeding.*—This was practised on a few farms in each class group; it was sometimes confined to one or two home-reared animals, but on several farms store cattle were purchased and fattened.

(b) *Horse Breeding.*—The breeding of horses had been practised to a considerable extent in the pre-war years and in some cases until quite recently, but as this enterprise

had not been remunerative only a few animals are now being bred. These are usually of the better class, as secondary animals are unprofitable.

(c) *Pig Keeping.*—Pigs were not found to be closely associated with dairying, although there were a few cases where this enterprise was developed. There was seldom any continued surplus of milk, and as the trade was a purely whole-milk one, there was little to commend the development of pigs as a means to use the surplus. As pigs had proved profitable, it was surprising that more were not kept. The usual method of management was to keep sows and sell young pigs at from eight to twelve weeks old.

(d) *Sheep.*—This class of stock was kept on a large proportion of the farms. On the smaller farms it was usual to find a few pedigree Border Leicester ewes for the production of breeding stock; on the larger farms flocks of breeding ewes, usually crossbreds, were kept and either store or fat lambs sold. The lambing period varied from February to April according to the system of disposal of the lambs.

(e) *Poultry.*—Poultry were mainly of the "farmyard" variety, and in most cases were allowed to take a very small place in the farm economy. On one or two farms where their importance was recognised and they received adequate attention they were reported to be showing a very good return.

Economic Aspects of Management.—The management of the farms varied greatly, and was found to be the most important factor influencing the success of the farms. The manager's ability may be considered under two distinct classifications :—

(i) The ability to plan a balanced business as a whole; and

(ii) The skill to put the organised plan into economic practice.

Most farmers had a well-organised plan of action, but there were a few who did not realise the advantages of a well-balanced diversification of enterprises, or of choosing such minor enterprises as could be efficiently operated without unduly adding to the general expenses of the farm.

As the dairy herd was in every case the major enterprise the labour requirement was based on the needs of the herd, and in some cases was rather greater than could be fully employed except at milking time. The problem of utilising this labour was in some cases solved by the hiring of part-time workers, i.e., workers' wives; but in other instances, where full-time workers were the rule, it would appear that enlarging the pig herd or poultry flock would be profitable.

The method in which the organisation was carried into practice in many cases was uneconomic, and often really well-planned organisations showed decided losses owing to inefficiency

or inability to cope with the minor factors, which in many enterprises greatly affect the financial result as a whole.

This fact was very apparent when the feeding practices were examined. In the area three main systems of feeding were practised, and, although there was no rigid dividing line, one could classify them roughly according as to whether home-grown foods, draff, or concentrated foods predominated in the ration.

The maintenance ration was in all cases made up of home grown feeds, and this classification refers wholly to the productive rations.

The home-grown foodstuffs consisted of large amounts of oats, hay and roots, with only a small amount of concentrate to provide the protein part of the ration. The use of draff was by far the most common and in many cases the feeds were large, but over all they varied from 15 to 50 lbs. per day per cow. Treacle and bran were often added to this ration, but only where the amount of draff was small did one find concentrates being fed, and then only in very small quantities. Those who chiefly used concentrates were in the very small minority, but in these cases it was found that most farmers were well versed in the principles of balanced feeding.

Very few herds were fed according to the yield, although some farmers did give high-yielding cows a little more food than the others; the usual procedure was to feed similar rations to all cows. In this way, when production was compared with the amounts fed, there was an apparent wastage of food. In several cases the ration could have been almost halved, and according to the recognised feeding principles no decrease in yield should have taken place. There was also much evidence that better balancing of rations would result in more economic feeding.

Labour.—The man labour on most of the farms was well organised, but several farmers could with ease reduce their staff or alternatively enlarge their minor enterprises. In several instances the employment of specialists such as pigmen and shepherds for small numbers of animals would hardly appear to be justified. One feature brought out by many of the farmers which might appear to justify the employment of an extra man is the fact that there are certain rush periods throughout the year when an extra hand is more or less necessary, and as casual labour is practically unprocurable a full-time worker must be kept.

Buildings.—The buildings on the farms were in some cases entirely suitable for the production of milk, but there were also many which were not. Many of the steadings were not well planned for the economising of labour. Byres were in some cases obviously not meant for milk production; ventilation was scanty and windows were few.

Marketing.—Many farmers purchased their requirements through a co-operative society, and in this way received any benefits, such as rebates, which were available. Instances of farmers using long term credits and being practically tied to the

merchant were found, but on the whole this was rare, as the steady income from the milk cheque allowed most farmers to meet their obligations at least monthly. Most farmers attended markets either weekly or fortnightly, and it would appear that in many cases there was no relation between the business done and the amount of time spent in markets.

Sales of live stock were usually effected through auction marts, grain was sold to merchants, while poultry and eggs were mainly sold to passing merchants' carts.

General Conclusions.—The figures obtained showed that 71 per cent. of the dairy farms showed a profit, the averages of the class groups varying from 9·6 per cent. to 18·2 per cent. on the capital invested. This figure was arrived at after debiting the farm with the value of the farmer's manual labour, but includes any payment for managerial supervision. This shows that on the whole the industry is profitable. As was found by investigators in a survey of a totally different farming area in Kincardineshire,[1] the main factor which affects the financial results of dairy farming is the personal efficiency of the farmer.

Reviews.

"*Agriculture: the Science and Practice of British Farming.*" James A. S. Watson and James A. More.—This excellent manual has secured testimony to its popularity in the need for a new edition, and advantage of the opportunity has been taken by the authors to bring the matter up to date. While all the chapters have been revised and partly rewritten, certain sections have been specially dealt with. In that relating to crops the latest classifications have been adopted for cereals; more space has been given to diseases of the potato; a chapter on sugar beet has been added; and much new matter has been introduced into the section on grassland, including an account of the intensive system of pasture management. The feeding of farm live stock has been dealt with on more modern lines than in the earlier edition, and the feeding tables in the appendix have been brought up to date.

Much care has evidently gone to the revision of the treatment of farm management. The selected examples of British farming systems are set forth in an eminently practical way, and a final chapter on costs of production deals sensibly with this highly debateable subject.

With the additions and modifications noted and many other minor alterations, the value of the treatise as a manual for students has been greatly enhanced. No more reliable or more lucid exposition of the science and art of agriculture is available either to the agricultural student or to the general reader interested in the subject.

[1] An Agricultural Survey of Kincardineshire, *Scottish Journal of Agriculture*, July 1926.

Great Britain—Essays in Regional Geography, by twenty-six authors. Edited by Alan G. Ogilvie. Cambridge University Press, 1928; pp. xxx, 486; price 21*s*.—This volume, which was prepared for publication on the occasion of the meeting of the Twelfth International Geographical Congress at Cambridge last summer, is an admirable example at once of modern geographical method and of co-operative authorship. Twenty-six authors, most of them representing geography at the various university centres, have collaborated, and the work is edited by Mr. A. G. Ogilvie, Reader in Geography in the University of Edinburgh, with an introduction by Sir John Russell. As Mr. Ogilvie says in his preface, and as is indicated by the sub-title, the book is to be regarded as a collection of essays and not as a systematic hand-book. The general scheme is, however, sufficiently clear to give organic unity to the work, and the result is a gratifying testimony to the advance that has been made in the last generation in the exposition of geography. England is divided into eighteen regions and Scotland into four, while Wales forms one, and Dr. H. R. Mill deals with the climate of Great Britain as a whole. The Highlands and Hebrides are described by Mr. A. Stevens of Glasgow University, North-East Scotland by Mr. J. M'Farlane of Aberdeen, and Central Scotland by the editor, who has collaborated with Mr. Stevens and Mr. W. A. Gauld in dealing with the Southern Uplands, this essay also including a contribution by the late Dr. W. G. Smith on the hill pastures of the Tweed Basin.

A great degree of compression has been necessary in order to embrace so large a subject in a single volume of 500 pages, although space is economised by frequent references to recent authoritative accounts of particular subjects. The scheme of each regional essay includes geology, rivers and lochs, human settlements past and present, communications and industry, with special reference to agriculture. Human activities are brought into relation with the natural conditions by which they have been determined and on which they have reacted. Statistics are used to give precision to the statements made, and many points are illustrated by ingenious and useful maps of the diagrammatic type. The need for compression has in most cases not suppressed but rather stimulated vividness of style. Every sentence is significant, and many are epigrammatic. Many holiday-makers will agree that the Highlands are "a moist habitat without definite summers." Aberdeen is "typical of the whole region of which it is the capital, a region in which the obstacles to human development have been great." Again, "the nearest modern counterpart of mediaeval life in Tweeddale is probably to be found in Albania." More broadly, one may say that the characterization of each region and its sub-divisions, based on accurate knowledge of fact and keen perception of natural and human qualities, is to a high degree successful. Whether for general reading or for use by teachers of geography, economics and agriculture, this book fills a place of its own. It may be

added that the printing and general style of the volume reach the high standard associated with the work of the Cambridge University Press.

A Tour in Australia and New Zealand. R. G. Stapledon. Oxford University Press.—An oft-quoted truism tells us that the eye sees what it brings with it the power to see. A landscape is quite differently seen by an artist, a geologist, and a farmer : and these great dominions of the Antipodes would be differently seen and variously described by different types of travellers. Professor Stapledon is an agrostologist; he is interested in grasses, and his main interest lies in the fuller development and utilization of the immense grassland resources of the Empire. With that as his viewpoint it might be inferred that this account of his journey would be largely technical and specialist in its nature. But it is not so. He takes account of many matters of more general interest, and even his review of the more technical problems encountered is pleasantly free from scientific terminology, and may be read with understanding and profit by all who have the welfare of the Empire at heart.

The importance of the grassland problem may be gauged by the facts noted that almost one-fourth of all Great Britain's imports is the product of the pastoral and allied interests; that one-half of all these imported grassland products comes from the Empire; that more than one-third of Australia's whole production is derived from grassland; and that of the total exports from New Zealand 94 per cent. is the product of grassland.

Professor Stapledon considers the problem of the extension of the grassland area from various standpoints. He gives sane and practical advice to the new settler who proposes to venture into unbroken country. He gives an interesting account of the winning of new agricultural lands such as the mallee scrub of Australia, and the irrigation colonies on the Murray River system; of the clearing of forest bush in Australia, Tasmania, and New Zealand; and of the specialised implements and methods of cultivation which have been evolved to meet the exigencies of the local conditions.

In the three last chapters the author reviews the whole grassland problem as an Empire question. He emphasises the need for knowledge of the management of grazing land—controlled grazing, fencing, provision of water, the use of grassland implements, especially the mowing-machine, the application of suitable manures. All this points to the need for organized research into the ecological and chemical sides of grassland management, and to the further and very important need for organisation in herbage seed production for the Empire.

Major Walter Elliot contributes a laudatory and informative foreword.

Craibstone.

Trials with Potatoes, 1928.—A problem which confronts those who sell seed potatoes is how to make the best use of the large tubers when ware is selling at a low price. Is it better to sell them at £2 to £3 per ton or to plant them, either whole or cut? The first consideration, of course, is that if planted whole it would require a considerable amount of seed (3 or 4 tons) to plant an acre, while if cut more labour would be necessary.

Notes from Agricultural Colleges.

Two different trials were carried out. In the first Great Scot was the variety used, and tubers of different sizes were planted 12 inches apart in 27 inch drills. The following result was obtained :—

Effect of Size of Seed—Great Scot.

Weight of Seed.	Crop per Acre.								Seed used.		Nett Crop.	
	Over 2¼ ins.		2¼ ins. to 1¼ ins.		Small.		Total.					
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
8 oz.	5	12	12	11	0	18	18	16	4	0	14	16
4 oz. ...	5	10	10	10	1	1	17	1	2	0	15	1
2 oz.	7	7	7	0	0	10	14	19	1	0	13	19
1 oz.	7	1	6	0	0	10	13	17	0	10	13	7

In the other trial different sizes of Majestic were planted at the same distances as the Great Scot. Some of the tubers were planted whole, while some of the large size were cut. As there are often blanks when Majestic seed is cut, the precaution was taken to cut the tubers some time previous to planting in order that the cut surface might heal slowly. Different methods of dealing with cut seed have been tried for several years, and this method has proved to be the most reliable, there being very few blanks.

The following result was obtained :—

Majestic.

Kind of Seed used.	Crop per Acre.								Seed used.		Nett Crop.	
	Over 2¼ ins.		2¼ ins. to 1¼ ins.		Small.		Total.					
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt
1½ ins. to 1¼ ins. whole	7	4	5	13	0	7	13	4	0	15	12	9
2 ins. to 1¾ ins. whole	6	6	9	13	0	7	16	6	2	0	14	6
Over 2¼ ins. whole	5	6	11	16	0	12	17	14	4	0	13	14
Over 2¼ ins. cut in 2	5	18	8	9	0	12	14	19	2	0	12	19
Over 2¼ ins. cut in 4	7	12	5	15	0	8	13	15	1	0	12	15
Over 2¼ ins. cut in 6	7	7	4	9	0	5	12	1	0	13	11	8

The following points will be noted :—

1. The largest whole seed has not given a sufficient yield to make up for the extra seed planted, whereas the medium-sized seed has given a good increase over the small seed.

2. The largest seed, however, has produced the largest amount of seed size—the most valuable part; whereas the small seed has produced more ware.

3. Cutting the large seed has not only reduced the total crop but also considerably reduced the amount of seed size tubers, although the amount of ware was increased.

From these results it would appear that it would be quite profitable to plant the large tubers rather than to sell them at a low price, but, of course, the true result will depend upon the selling price of ware and seed in the following year.

During the last few years plots with about 50 of the chief varieties of potatoes have been planted, and, on the average, Ally has not only produced the heaviest crop, but has also always been among the leaders. This year it is again better than all varieties except Arran Banner, which was registered by the Board of Agriculture for Scotland in 1927. The comparative yields are as follows :—

	Crop per Acre.							
	Over 2¼ ins.		2¼ ins. to 1¼ ins.		Small.		Total.	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
Ally	4	19	10	6	1	18	17	3
Arran Banner	11	8	6	8	1	5	19	1

During the last few years Great Scot and Golden Wonder have been planted at fortnightly intervals from 1st March, half the seed being sprouted and half unsprouted. In most seasons sprouting increases the yield. While this was so in 1928 with Golden Wonder and the late-planted Great Scot, the early-planted unsprouted Great Scot produced a heavier crop than the sprouted.

	Golden Wonder.				Great Scot.			
	Sprouted.		Unsprouted.		Sprouted.		Unsprouted.	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
March 1st	14	14	13	3	17	0	18	15
April 1st	13	13	11	16	16	8	15	7
May 1st	11	16	10	10	16	5	14	19
June 1st	11	5	9	3	15	15	13	2

This result is due to the fact that the plants were not frosted or destroyed by blight, as is generally the case in other seasons, but kept green and formed tubers much later in the season than is generally the case. (This is the reason for the heavier crops in the country this year.) The early-planted sprouted seed, on the other hand, was ripe earlier, and consequently did not benefit from the late tubering season.

The effect of the time of planting has varied considerably in different seasons. Generally the earliest planting (in March)

has not been so successful as that in April, but in 1928 the March planting was best, especially with Golden Wonder. The best time, of course, would depend on the condition and temperature of the soil. It would be unwise to plant potatoes in a cold, wet soil early in the season.

The selection of Golden Wonder free from mosaic, started in 1919, is being continued, but there is still a small proportion of plants affected with this disease. The difficulty in getting an absolutely free stock appears to be due to the fact that the disease is often masked. As in the past few years, a trial to demonstrate the effect of good and poor treatments was made with stocks of Golden Wonder. The treatments and results are as follows :—

	Over 2¼ ins.		2¼ ins. to 1¼ ins.		Small.		Total.	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
Good treatment — Without mosaic, Sprouted, Well manured ...	6	14	8	16	0	14	16	4
Poor treatment — With mosaic, Unsprouted, Poorly manured ...	3	7	6	8	0	16	10	11

The former shows an increase of nearly 60 per cent., which may be credited equally to the good stock, the sprouting and the manuring.

Kilmarnock.

Oat Variety Trial.—Almost every year sees the introduction of some variety or strain of oat bearing an unfamiliar name. To place these as far as possible in their proper categories repeated variety trials have to be conducted. The newcomers to Kilmarnock last spring were " Echo " and " A.88." These were grown side by side with a number of proved " grain producers " and ".straw producers," and their relative yielding power ascertained. Observations were made on all the varieties to determine also their comparative standing powers and earliness of ripening.

The oats were grown on land which had previously been under swedes. A complete and uniform manuring of phosphoric acid, potash and nitrogen was given, and an attempt was made to seed each variety at, as nearly as possible, three million seeds per acre. This necessitated sowing the largest grained varieties at as much as 270 lbs. per acre and the smallest grained varieties at about 170 lbs.

Alternately with each variety, Victory was grown as the control. The varieties in order of ripening were :—1, Yielder; 2, Superb; 3, Abundance; 4, Victory; 5, Ascot; 6, White Horse; 7, Crown; 8, Glebe; 9, Record; 10, Cropwell; 11, Echo; 12, A.88.

The first three may be classed as early, numbers 4 to 6 as

intermediate, numbers 7 to 11 as late, and 12 as very late. During the earlier part of the growing season " A.88 " was the outstanding variety, but it was latest in shooting into ear and the last in ripening by a week.

" A.88 " is a sided oat of the Tartarian type, being not unlike Leader in appearance. The grain is rather long and husky, while the straw is soft and difficult to keep upright in the stook.

In spite of the heavy rains towards the end of August and the beginning of September, lodging was not as serious a problem as in the previous season. But from such observations as could be taken the standing power appeared to be in the following order :—1, Yielder; 2, Record; 3, Echo; 4, Cropwell; 5, Abundance; 6, Glebe; 7, Ascot; 8, White Horse; 9, Victory; 10, Crown; 11, A.88; 12, Superb.

One of the worst features of Superb—as was evidenced from a field crop of this variety grown on the farm—appears to be that unless the oats are cut prior to, or just at, the ripe stage, the ears become too heavy for the straw and bend over until they almost touch the ground, rendering harvesting difficult and causing a considerable loss of grain in cutting.

The actual yield obtained from the check plots of Victory was equivalent to fully 31 cwt. per acre of dressed grain and 2 tons 2 cwt. of straw.

The yields from the other varieties, expressed in percentages of the average of the control plots of Victory, were :—

Variety.	*Grain.*	*Straw.*
Victory	100	100
Yielder	102	86
Record	101	93
Crown	99	115
Echo	97	110
Superb	95	109
A.88	92	120
Ascot	89	98
White Horse	84	107
Glebe	80	116
Abundance	80	94
Cropwell	74	82

Lodging of Oats.—In previous experimental work on the lodging of oats carried out at the College Farm, Kilmarnock, and at other centres in the south-west of Scotland the vagaries of the climate have almost always nullified the effect of the treatment, and generally either all the trial plots were standing at harvest time or they were all down. In view of these facts it was decided that in any further lodging trials the plots should, as a preliminary, be sufficiently heavily dressed with nitrogenous manure as greatly to encourage lodging, and that other manurial constituents should be given to determine what counteracting effect, if any, might accrue from their application.

The 1928 trial was of a preliminary nature, but it is significant that, while many of the plots were badly lodged, some of them, though exceptionally heavy, successfully withstood the wind and rains of late August and early September and kept up till harvested. This was all the more remarkable in view of the fact that these plots received a dressing at the rate of 2 cwt. sulphate of ammonia per acre or the equivalent amount of nitrogen in nitro-chalk.

The best results were obtained from supplementary dressings of mineral phosphate, muriate of potash and lime.

As already indicated, the trial was only a preliminary one, but the results are suggestive and form a basis for further investigation.

Manuring of Oats.—Visitors to the Experiment Station during the season of 1928 were generally of opinion that the application to the oat crop of 1 cwt. sulphate of ammonia per acre in addition to phosphates and potash would increase the yield of grain by at least 4 cwt. per acre over the plots receiving only phosphates and potash. Results of previous experiments have shown this estimate to be very near the mark.

The experiment under consideration was one in which the newer nitrogenous manures were being compared with the older and better known ones.

In the trial the check plots which alternated with the others were manured with sulphate of ammonia, superphosphate and potash, while the other plots received an equivalent amount of nitrogen as nitrate of soda, nitrate of lime, calcium cyanamide, muriate of ammonia, nitro-chalk and urea.

Every one of these nitrogenous manures gave a very material increase in the yield of grain and straw, but a noteworthy feature of the trial was the fact that calcium cyanamide hastened the ripening by as much as four days in comparison with most of the other plots of the series. Nitro-chalk had a similar effect though to a rather less marked degree. The effect of calcium cyanamide in hastening ripening had been previously noted in some of the county trials.

Strains of Red Clover.—Numerous trials have now been carried out for the purpose of testing the lasting powers of Early and Late Flowering Red Clovers from different sources, and these have always proved of very special interest and value to farmers and seedsmen visiting the Experiment Station.

Amongst the Early Flowering Reds some have proved very short lived and others much more persistent.

The late Professor M'Alpine, as a result of his trials, was very emphatic regarding the superiority of Canadian Early Red in that respect, and subsequent work at the Experiment Station has fully confirmed that view, and at the same time has shown that American or Wisconsin Clovers are also very persistent.

Of the Early Flowering Reds the Italian, the Chilian and the French are usually the least persistent. The Italian in particular may look very well in the "seeds" after the "nurse" crop

has been harvested, but if the winter is severe it dies out and does not even last for the first hay crop. The English Early Red is rather better than the foregoing strains, and normally it gives a good return in the first season. It is, however, of very little account in the second and subsequent years. Canadian and American Clovers, on the other hand, are rather remarkable as regards their longevity. They still persist, though now somewhat sparsely, in mixtures sown down in 1923 even after having been cut for hay for five successive years.

In a new series of trial plots put down in 1927 and cut for hay in 1928 the Canadian Early Red has again given one of the largest yields of the series, and at the time of writing it gives promise of being one of the best.

The American and the Wisconsin are also very good. The Italian has fully disappeared, and serious thinning out has taken place with the French, Chilian, and to a less extent with the English.

The yields of hay from these plots in 1928 were as follows :—

	Tons	Cwts.
English Early Red	4	5
Canadian do.	4	15
American do.	4	5
Wisconsin do.	4	10
French do.	4	15
Italian do.	4	10
Chilian do.	4	15

The components in the seed mixture in addition to 4 lbs. Red Clover were :—Perennial Ryegrass 15 lbs., Italian Ryegrass 9 lbs., Cocksfoot 3 lbs., Timothy 3 lbs., Wild White Clover 1¼ lbs., Alsyke Clover 1½ lbs.

Labour on Scottish Farms.

THE Agricultural Returns collected on 4th June 1928 give the following numbers of workers employed on that date on holdings exceeding one acre in extent. The occupiers of holdings, their wives and domestic servants are excluded, but members of the occupiers' families other than their wives are included.

	Regular Workers.	Casual Workers.
Males, 21 years old and over ...	59,897	6,140
Do. under 21 years old ...	21,709	3,181
Total of Males	81,606	9,321
Women and girls	18,957	7,416
Total	100,563	16,737
Grand Total ...	117,300	

The grand total is 1,975 below that recorded in 1927, regular

workers having decreased by 1,022, or 1 per cent., and casual workers by 953. Of the regular workers, men over 21 have increased by 71, while males under 21 are fewer by 564, or 2·5 per cent., and women and girls by 529, or 2·7 per cent. The changes in the numbers of casual workers have less significance, but it may be noted that the decrease is mainly accounted for by women and girls and to a less extent by males under 21, while men over 21 were employed in larger numbers on 4th June 1928 than on the same day in 1927.

Seed Testing and Plant Registration Station for Scotland.

THE work of the Station was up to the year 1925 more or less fully dealt with in the Annual Reports of the Board of Agriculture for Scotland, but it was felt that a fuller account of the Station and its work was necessary for the information of those interested in seed testing and the control of plant diseases. The First Report of the Station, which has recently been issued, gives a fully illustrated description of the equipment of the Station and of the methods employed, with particulars of the work carried on in the years 1925-6 and 1926-7 in connection with Seed Testing and Plant Registration; it also includes reports of the proceedings of the Potato Synonym Committee. The Report, which is issued as "Miscellaneous Publications, No. 8," may be obtained from the Offices of the Department, York Buildings, Queen Street, Edinburgh, price 2*s*. net, post free.

Electricity Supply in Rural Areas.

FOLLOWING on the passing of the Electricity (Supply) Act, 1926, the Electricity Commissioners decided to undertake a general review of the question of rural electrification in Great Britain and, *inter alia*, convened a Conference in November, 1927, to which representatives of the various Government Departments and of Associations and other bodies and individuals interested were invited. Two sub-committees were appointed by the Conference to investigate and report on different aspects of the subject.

A further meeting of the Conference was held in June 1928, and the Report [1] of the Proceedings at that meeting is now available.

The report of sub-committee No. 1 surveys the characteristics of rural areas, the extent of the supply, and the nature and

[1] *Report of Proceedings of Conference on Electricity Supply in Rural Areas*, Price 1*s*. net.

extent of the present demand for electricity. The conclusion is drawn that much scope exists for the further application of electricity in connection with farming and horticultural operations, and that a potential demand growing to the order of 230,000,000 units per annum in the course of the next ten years is indicated for rural areas in Great Britain where supply powers already exist. The committee point out, however, that for economic reasons rural electrification cannot be proceeded with to the extent of making a supply of electricity available to every inhabitant, farm and other premises in rural Britain. The prospects in the very sparsely populated and remote areas are of such a low order as to preclude, or at any rate to delay for many years to come, the establishment of a public supply on a remunerative basis.

Sub-committee No. 2 recorded the view that the development of rural electrification on a commercially remunerative basis depended upon :—

(1) the reduction to a minimum of capital expenditure on transmission and distribution by the adoption of an overhead system of inexpensive design;

(2) the provision of an unrestricted electrical service, and the best possible facilities in the way of assisted wiring schemes and for the hire or hire-purchase of apparatus;

(3) the offer to consumers of an attractive two-part or "all-in" tariff permitting of the general use of electricity for all purposes at a relatively low charge; and

(4) adequate publicity and demonstration to acquaint the rural population with the various methods of utilising electricity for labour-saving appliances in domestic premises, on farms, and in small workshops.

The recommendations made by the Conference include the following :—

(1) That the Electricity Commissioners be asked to regard the development of electricity supply in rural areas as a special branch of their work, to which continuous attention should be devoted, and to consider the advisability of appointing a special officer for the purpose.

(2) That the Commissioners be asked to undertake a review of their new Code of Overhead Line Regulations within the next two years, with a view to effecting further reductions in the cost of rural lines by relaxations as regards ground clearance and factors of safety in respect of lines for supplying sparsely populated rural areas; and to consider the practicability of providing for different classes of construction for different types of rural areas.

(3) That the Commissioners be asked to urge undertakers to make a periodic canvass of the potential demand in the unsupplied portions of their areas, and to take such steps as are possible from time to time to ensure that undertakers carry out their obligations in cases where there is a

reasonable prospect of supplies being given on a remunerative basis.

(4) That undertakers who are in a position to extend supplies into neighbouring "unoccupied" areas should be urged by the Commissioners to consider the question of carrying out such extensions, and of obtaining powers for that purpose in the absence of any other satisfactory proposals for supplying the areas in question.

(5) That with the view of facilitating the electrification of farms occupied by tenants, the representative associations concerned be urged by the Commissioners to confer on the question of obviating the risk of loss by tenant farmers on expenditure on electrical equipment in the event of an early termination of tenancy.

The Conference also recommended that the principal Government Departments concerned be asked to consider jointly the question of taking steps to secure the further investigation of the various other aspects of rural electrification, including the collation and issue of such information as is likely to assist its development.

The Residual Values of Feeding Stuffs and Fertilisers.

IN the Report of the Joint Committee of scientific and professional men on the residual values of feeding stuffs and fertilisers which was published by the Board in 1927—Miscellaneous Publications No. 7—it was recommended that a committee should be appointed to recalculate the tables annually in accordance with the variations in the market price of manures. Accordingly the Board appointed Sir James I. Davidson, Saughton Mains, Corstorphine; Professor James Hendrick, B.Sc., F.I.C., North of Scotland College of Agriculture, 41½ Union Street, Aberdeen; and Mr. John Speir, Newton Farm, Hallside, Glasgow, to be the members of this Committee.

The Board received the Committee's report containing their recommendations for the revision of the tables after consideration of the current market price of manures, adopted the Committee's recommendations and arranged for the publication of the revised tables. These tables, which are substituted for those published in 1927, appear at Appendix A of Miscellaneous Publications No. 7 (1928 edition), which has just been issued. Copies of this publication may be obtained from the Department, price 6*d*. net, post free.

General Assembly of the International Institute of Agriculture.

THE Ninth General Assembly of the International Institute of Agriculture was held in Rome from 10th to 18th October 1928, and was attended by 157 delegates representing 66 different countries. The British delegation included representatives of the Ministry of Agriculture and Fisheries, the Board of Agriculture for Scotland and the Ministry of Agriculture, Northern Ireland, and also a representative of farmers' associations in Great Britain.

In view of the limited income at the disposal of the Institute, the British delegation presented a memorandum urging that it should, for the time being, abandon the attempt to cover the whole field of scientific and technical activity, and should devote its energies mainly to statistical and economic investigation. This memorandum was favourably received by the Assembly, and its main points were embodied in resolutions which were, after discussion, unanimously accepted. It is proposed that scientific experts should be invited to contribute from time to time accounts of particular developments of importance to agriculture, to be published in the Institute's "Review"; this will enable the staff of the Bureau of Agricultural Intelligence to be considerably reduced. The resolution regarding the development of the Institute's statistical and economic work was supplemented by others recommending the acceleration of the receipt and diffusion of information of this kind, the preparation of index numbers of the prices of agricultural products and of the various elements of the cost of production, and the improvement of the statistics relating to tropical products.

The terms of the British memorandum governed the procedure of the Assembly in dealing with various proposals put before it, and enabled it to draw up a coherent and realisable programme of work for the immediate future.

The World Census of Agriculture to be taken in 1930 was again under discussion, and before the Assembly met there was a conference of statisticians which dealt with various questions left over from the meeting of 1926. The general feeling was that the "standard form" should be as simple as possible, and that a large measure of freedom should be left to each State in making its arrangements for co-operation in the Census.

Certain changes in the Statutes of the Institute were made, the effect of which is to reduce the executive power of the President and to place a greater degree of responsibility in the hands of the Secretary-General, under the supervision of the Permanent Committee. The post of Secretary-General is at present vacant, and the British memorandum laid great stress on the need for securing the services of a man of recognised reputation and position. A resolution moved by the British delegation that the Permanent Committee should at once proceed to appoint a Secretary-General on the ground solely of qualification (i.e. without regard to nationality) was passed.

A further change proposed by the British and other delega-

tions was that the Permanent Committee, instead of meeting as at present at least once a month with a vacation of three months, should meet quarterly, probably for several days, for the purpose of dealing thoroughly with important questions of policy and administration. The General Assembly could not constitutionally decide this question, but it was agreed by a large majority to recommend to the Permanent Committee that it should alter its standing orders in this sense.

At present, while the more important States keep permanent delegates in Rome, others are represented, for convenience, by members of the diplomatic body. The proposed alteration will, it is hoped, enable many States to send experts as delegates to the periodical meetings of the Permanent Committee.

International Yearbook of Agricultural Statistics, 1927-28.

THE International Institute of Agriculture at Rome has recently published its *International Yearbook of Agricultural Statistics* 1927-28. This Statistical Yearbook has from the first been a special feature among the publications of the Institute, the first volume being issued in 1910 and others following in regular succession despite the special difficulties of the war period. The present Yearbook is actually the seventeenth of the series, and as usual it contains a mass of agricultural data and material such as by the nature of the case are not to be found in any other publication of similar character.

An idea of its comprehensive nature may be gained by a glance at the subjects of the nine chapters into which this stout volume of nearly 600 pages is divided.

These are as follows: (*a*) Territorial area and population as in 1913 and in 1927 for 220 countries; (*b*) Apportionment of areas, agricultural production and numbers of live stock in 1926 and 1927 for 47 countries; (*c*) Area, production and yield per hectare for 35 agricultural products for all countries (averages for 1909-1913 and 1924-1927 respectively); (*d*) Numbers of the nine principal species of live stock for various countries; (*e*) Data of imports and exports relating to 40 vegetable and 5 animal products for various countries; (*f*) Prices for all the chief agricultural products; (*g*) Ocean freight rates for cereals and cotton; (*h*) Production, trade and consumption of chemical fertilisers; (*i*) Rates of exchange.

The statistical tables are elucidated and explained in an introductory chapter, and the work as a whole will be found to be not only of great practical interest to persons directly occupied in agriculture, trade and finance, but also of very real assistance to all students of world economic problems as they present themselves to-day.

The publication may be obtained from the Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W. 1, price 20*s*. in paper cover, 22*s*. bound in cloth.

Annual Estimates of the Produce of Crops. THE following statement regarding the produce of crops for 1928 was issued on 11th December :—

Preliminary Statement showing the ESTIMATED TOTAL PRODUCE and YIELD PER ACRE of Wheat, Barley, Oats, Beans, Hay, Potatoes and Roots, in SCOTLAND in the Year 1928, with COMPARISONS for 1927, and the AVERAGE YIELD PER ACRE of the Ten Years 1918-27.

CROPS.	Estimated Total Produce.		Acreage.		Average Estimated Yield per Acre.		Average of the Ten Years 1918-1927.
	1928.	1927.	1928	1927.	1928.	1927.	
Wheat ...	*Tons.* 62,000 *Quarters.* 282,000	*Tons.* 65,000 *Quarters.* 305,000	*Acres.* 58,227	*Acres.* 66,577	*Cwt.* 21·2 *Bushels.* 38 7	*Cwt.* 19·6 *Bushels* 36·6	*Cwt.* 21·2 *Bushels.* 38·7
Barley (including Bere) ...	*Tons.* 103,000 *Quarters.* 532,000	*Tons.* 94,000 *Quarters.* 509,000	111,924	117,369	*Cwt.* 18·4 *Bushels* 38·1	*Cwt.* 16·1 *Bushels* 34·7	*Cwt.* 17·4 *Bushels.* 36·2
Oats ...	*Tons* 704,000 *Quarters.* 4,797,000	*Tons.* 620,000 *Quarters.* 4,366,000	878,436	897,370	*Cwt.* 16·0 *Bushels.* 43·7	*Cwt.* 13·8 *Bushels.* 38·9	*Cwt.* 14·5 *Bushels.* 39·9
Beans ...	*Tons.* 3,000 *Quarters.* 13,300	*Tons.* 3,000 *Quarters.* 14,000	3,151	3,574	*Cwt.* 18·9 *Bushels.* 33·7	*Cwt.* 16 9 *Bushels.* 31·2	*Cwt.* 18·4 *Bushels.* 33·8
Hay from Rotation Grass	*Tons.* 627,000	*Tons.* 647,000	400,753	399,672	*Cwt.* 31·3	*Cwt.* 32·4	*Cwt.* 31·5
Hay from Permanent Grass ...	152,000	162,000	117,286	118,290	26 0	27·3	25·9
Hay from Timothy Meadows ...	105,000	105,000	49,014	48,922	42 8	42·9	42·8
Potatoes	1,032,000	799,000	144,026	147,184	*Tons.* 7·2	*Tons* 5·4	*Tons.* 6·5
Turnips & Swedes	6,660,000	5,937,000	378,003	376,698	17·6	15·8	16·6
Mangolds ...	21,600	20,400	1,250	1,124	17·3	18·1	18·0

NOTE.—As a consequence of the lateness of the cereal harvest in 1927 and the wet weather during the autumn months the sowing of winter wheat was protracted. Speaking generally, germination was unusually slow until the middle of February,

when dry spring-like conditions favoured the development of the plants for two or three weeks. Towards the end of February considerable areas of wheat were sown under good conditions; the total acreage sown was, however, less than in the previous year. Growth was checked by cold weather in April, May and June, but during July the weather was more favourable and there was a decided improvement in the appearance of the plants. Some lodging occurred during August but most of the crop stood well. Cutting became general during the second half of September and the bulk of the crop was stacked before the end of that month; the grain is said to be of fair average quality. The seeding of barley was carried out rather late in some districts but the crop brairded well. As in the case of wheat, ripening was slower than usual and in the eastern counties considerable portions of the heaviest crops were laid by rain. Some of the grain was ready for cutting at the end of August but the weather was then unfavourable and harvest was not general until the second week of September; at the end of October in late districts there were still small portions of the crop uncut. The grain is of good average quality and, where it was harvested before the weather became broken, it was secured in satisfactory condition. The early reports on the oat crop were not quite so good as those for wheat and barley; in many districts germination and growth were rather unsatisfactory and the plants were thin on the ground. Damage by grub or wire-worm was general, more especially in the eastern counties. During July the outlook improved, but the low temperature tended to shorten the straw and the grain ripened slowly. Oats did not withstand the effects of the broken weather quite so well as wheat or barley and portions of the crop were lodged. Harvest generally was in full swing by the end of September but the work was delayed by rain and some of the crop was damaged. In some western areas the grain is of unusually good quality; elsewhere it is generally up to the average but a considerable amount of the crop was secured in an unripe condition and several complaints have been received of heating in the stack.

Very little progress was made with the planting of early varieties of potatoes before the month of March, while in several districts the planting of maincrop varieties was delayed until the end of May. Growth was slow during June and July and at the beginning of August some of the haulms were rather stunted as a result of the cold weather. The condition of the crop showed considerable improvement during the following months, however, and although the proportion of the total acreage reported to have been sprayed was almost negligible there were few complaints of disease. The sowing of turnips and swedes was completed in fair order but the braird was at first rather irregular owing to the dry condition of the soil during May. Where sown late, the braird was stronger and the plants made good progress, despite the cold weather. The reports on the crop improved steadily as the summer advanced but "finger-and-toe" was

prevalent in a number of eastern counties. At the end of October the roots had developed into a sound bulky crop of good quality.

The total produce of wheat, 62,000 tons, is less than in 1927 by 3,000 tons or 4·6 per cent. The area under the crop has decreased by 8,350 acres but the average yield per acre has increased by 1·6 cwt. and is the same as the decennial average. Barley, with a total produce estimated at 103,000 tons, shows an increase of 9,000 tons or 9·6 per cent. As compared with 1927, the area harvested is less by 5,445 acres but the average yield per acre, 18·4 cwt., is in excess of last year's figure by 2·3 cwt. and is above the decennial average by 1·0 cwt., while the average yield by measure 38·1 bushels exceeds that of 1927 by 3·4 bushels. The total production of oats is shown as 704,000 tons, an increase as compared with the previous year of 84,000 tons or 13·5 per cent. The area under the crop has decreased by 18,934 acres but the yield per acre, 16·0 cwt., is greater than last year by 2·2 cwt., and exceeds the decennial average by 1·5 cwt. The produce of beans, 3,000 tons, is the same as in 1927 although the area shows a decrease of 423 acres. The yield per acre, 18·9 cwt., is greater than last year by 2·0 cwt. and is 0·5 cwt. above the decennial average.

The total produce of hay, taking all kinds together, is 884,000 tons, being 30,000 tons or 3·3 per cent. less than in the previous year. Hay from rotation grass shows a total production of 627,000 tons, a decrease of 20,000 tons or 3·1 per cent. The yield per acre, 31·3 cwt., is less than in 1927 by 1·1 per cent. and is below the decennial average by 0·2 per cent. The total produce of other hay, which amounts to 257,000 tons, or 10,000 tons less than in 1927, comprises 152,000 tons from ordinary meadows and 105,000 tons from timothy meadows. The yield per acre of ordinary meadows, 26·0 cwt., is 1·3 cwt. less than last year's figure, but is slightly above the decennial average, while the yield per acre of timothy meadows, 42·8 cwt., is 0·1 cwt. less than in 1927 but 0·5 cwt. greater than the ten years' average. The average yield of the two together, which is not shown on the table, is 31·0 cwt. or 0·2 cwt. above the decennial average.

The total produce of potatoes, amounting to 1,032,000 tons, shows an increase of 233,000 tons or 29·2 per cent.; the area under the crop, 144,026 acres, is less than in 1927 by 3,158 acres, but the yield per acre, 7·2 tons, is 1·8 tons greater than last year and is 0·7 tons greater than the decennial average. The produce of turnips and swedes, 6,660,000 tons, has increased by 723,000 tons or 12·2 per cent., while the area, 378,003 acres, is 1,310 acres greater than last year. The yield per acre, 17·6 tons, is 1·8 tons more than in 1927 and 1·0 ton above the decennial average. Mangolds show a total produce of 21,600 tons, or 1,200 tons greater than in 1927. The area under the crop, 1,250 acres, is 126 acres greater than last year; the yield per acre, 17·3 tons, is 0·8 ton less than in 1927 and 0·7 ton below the decennial average.

With the exception of hay and mangolds all crops show higher yields per acre. Barley, oats, potatoes, turnips and swedes and mangolds show increased total yields, although decreased acreages are returned under all these crops, except turnips and swedes.

Returns of Acreage under Varieties of Potatoes.

THE following table shows the acreage under immune and non-immune varieties of First Earlies, Second Earlies and Maincrops for the years 1918 to 1928, and it is of interest to compare the great increase in the acreage under immune varieties with the decrease under non-immune varieties during this period. It should be stated that the figures in the table do not include areas of less than one acre under potatoes, nor have areas under potatoes in the following districts been taken into account:—Skye, Harris, North and South Uist, Western Ross, South Western Ross and Lewis.

YEAR.	FIRST EARLIES		SECOND EARLIES.		MAINCROPS.	
	Immune.	Non-Immune	Immune.	Non Immune.	Immune	Non Immune.
	Acres	Acres.	Acres,	Acres.	Acres	Acres
1918	186	12,563	12,209	12,201	15,050	79,766
1919	667	13,197	19,644	9,314	17,080	62,870
1920 .	1,572	13,454	30,084	7,957	29,411	54,128
1921 ..	1,051	14,066	22,537	5,916	35,375	50,076
1922 .	586	15,695	18,211	6,038	39,559	56,992
1923	674	16,511	12,920	5,961	38,190	43,720
1924	584	15,051	11,663	5,738	42,856	43,296
1925 ..	473	15,380	11,550	5,983	52,161	37,433
1926	357	14,764	13,448	6,188	52,222	36,278
1927	332	15,596	15,887	5,401	58,495	33,491
1928	279	14,722	15,252	4,013	67,109	24,680

Acreage under each Variety of Potatoes in 1928.

A STATEMENT is printed on p. 109 showing the acreages under certain varieties of potatoes in Scotland in 1928, as returned by growers of one acre or over. These returns cover 126,895 acres out of the total acreage of 144,026, the difference being accounted for by the total exclusion of certain districts in the Highlands and Western Islands, and by the exclusion of holdings on which less than one acre is grown. The total acreage shows a decrease of 3,158 acres as compared with 1927, and the acreage included in the returns of varieties a decrease of 3,069 acres.

The area under First Earlies, 15,059 acres, shows a decrease of 925 acres, or 5·8 per cent., as compared with 1927, and is slightly under that returned in 1926. Epicure, with 8,128 acres, or 477 less than last year, accounts for 53 per cent. of the total. Eclipse, with a decrease of 405 acres, covers 2,878 acres, which is

about 300 acres under the combined acreage of the next two varieties—Duke of York, 1,850, and Sharpe's Express, 1,341. These four varieties cover, as last year, 94 per cent. of the whole area under First Earlies. Herald, registered by the Board as a new immune variety, appears for the first time with 38 acres.

Second Earlies, with a total acreage of 19,413, fall short of that recorded in 1927 by 1,964 acres, or 9·2 per cent., and are slightly below the level of 1926. Great Scot, with a decrease of 445 acres, covers 12,287 acres. British Queen again shows a substantial decrease, its area being 3,568 acres as against 4,939 last year, while Ally is practically unchanged with 1,542 acres. These three varieties account for 90 per cent. of the total.

The area under Maincrops, 92,423 acres, shows a slight decrease of 180 acres as compared with 1927. Kerr's Pink, with a remarkable increase of 9,180 acres, now stands at 44,539, and accounts for 48 per cent. of the whole area under Maincrops. King Edward VII, with 13,310 acres, or only two-thirds of last year's figure, retains the second place, while Arran Chief, Majestic and Golden Wonder follow with 8,343 acres, 8,024 acres and 7,429 acres respectively, all of them showing considerable reductions. These five varieties account for 88 per cent. of the Maincrop acreage. Of the other varieties, the most notable is Arran Consul, the area under which has risen from 693 to 2,430 acres. The Sutton's Abundance group, Field-Marshal and the Up-to-Date group show diminished acreages, as do ten out of the fifteen minor varieties. Arran Banner, registered by the Board as a new immune variety, appears for the first time with 81 acres.

Varieties immune from wart disease cover in all 82,640 acres, or 65·1 per cent. of the total area included in the returns; non-immune varieties cover 43,415 acres, or 34·2 per cent.; while the varieties not specified in the returns account for only 840 acres, or less than 1 per cent. The proportion under immune varieties in 1918 was 19·5 per cent. For the five years 1924 to 1928, it has been 45·9 per cent., 51·7 per cent., 53·2 per cent., 57·5 per cent., and 65·1 per cent. Thus the figure for 1928 shows a more decided advance than has before been recorded.

Agricultural Returns for Scotland, 1928.

THE Abstract of the Agricultural Returns printed on pp. 110–117 shows that the total area under all crops and grass amounts to 4,665,462 acres, a decrease of 15,759 acres as compared with 1927, the arable land being less by 35,194 acres, while the area under permanent grass is greater by 19,435 acres. The land under rye-grass and other rotation grasses and clover has increased by 9,906 acres, the decrease in the area under other crops being thus 45,100 acres.

The total area under the cereal crops is 1,058,036 acres, being 33,368 acres less than in 1927. The area under wheat shows a

diminution of 8,350 acres or 12·5 per cent. Barley has decreased by 5,445 acres or 4·6 per cent., and oats by 18,934 acres or 2·1 per cent.; the areas under these two crops are the lowest on record.

Beans show a decrease of 423 acres or 11·8 per cent., and the area under potatoes is less by 3,158 acres or 2·1 per cent. The area under turnips and swedes is greater than in 1927 by 1,310 acres or 0·3 per cent., and mangolds show an increase of 126 acres or 11·2 per cent., while sugar beet has decreased by 8,039 acres or 77·7 per cent. Cabbage shows an increase of 122 acres or 2·9 per cent., and rape a decrease of 1,226 acres or 9·5 per cent., while only 3 acres have been returned under flax as compared with 206 acres last year. The area under vetches, tares, &c., for fodder has increased by 290 acres or 2·5 per cent.

Rye-grass and other rotation grasses and clover show a gross increase of 9,906 acres or 0·7 per cent., the area for hay being greater by 1,081 acres and that for pasture by 8,825 acres. The area under permanent grass shows a net increase of 19,435 acres or 1·3 per cent., the area for hay being less by 912 acres, but that for pasture being greater by 20,347 acres.

The area under wheat, barley, oats and potatoes this year is 1,192,613 acres, which is 35,887 acres less than last year and is the lowest aggregate recorded.

The live stock returns show that cattle and sheep have increased in number while horses and pigs have decreased. Horses used for agricultural purposes are less numerous by 3,662, unbroken horses of one year and above by 753, and those under one year by 578. "Other horses" have decreased by 1,371, the total decrease in all classes being thus 6,364 or 3·7 per cent. Cows in milk have increased by 661 or 0·2 per cent., and cows in calf by 1,539 or 3·1 per cent. Heifers in calf, on the other hand, show a decrease of 3,300 or 5·9 per cent., and bulls being used for service are fewer by 547 or 3·1 per cent. Other cattle of two years old and above have decreased by 14,340 or 6·9 per cent., while those of one year and under two have increased by 13,666 or 4·9 per cent., and those under one year by 5,719 or 2·3 per cent. The total number of cattle has thus increased by 3,398 or 0·3 per cent. Sheep are more numerous than in 1927 by 43,227 or 0·6 per cent., and the total number is the largest recorded since 1898. Breeding ewes have increased by 36,022 or 1·1 per cent., but rams are fewer by 184 or 0·2 per cent. Other sheep, one year and above, have increased by 742 or 0·1 per cent., while those under one year are more numerous by 6,647 or 0·2 per cent. The number of pigs, 195,504, is less than in 1927 by 1,109 or 0·6 per cent. Sows have decreased by 4,452 or 16·7 per cent., and boars by 254 or 9·4 per cent., while other pigs have increased by 3,597 or 2·2 per cent.

The acreage under rough grazings, 9,707,768 acres, is less than last year by 189,086 acres. This acreage includes 693,926 acres of deer forest land used for grazing which was formerly returned by sheep farmers as rough grazings, but which, on

investigation, has been found to be actually deer forest land made available for grazing. The total figures for cattle and sheep in Scotland include 3,468 cattle and 84,676 sheep grazing in deer forests on 4th June. Of these, 1,738 cattle and 57,546 sheep were included in returns made by agricultural occupiers and are now brought under the heading of deer forest stock. The remaining 1,730 cattle and 27,130 sheep were not included in any Agricultural Returns, and represent the stock pertaining to deer forests as such.

The returns include statistics of the acreage owned by occupiers of holdings and particulars relating to poultry. These particulars are not included in the printed Abstract.

The total area of land under crops and grass returned as owned by occupiers of holdings in 1928 amounts to 1,318,859 acres as compared with 1,226,393 acres in 1927, an increase of 92,466 acres. This area is 28·3 per cent. of the whole area of land under crops and grass; in 1927 the proportion was 26·2 per cent.

The poultry figures are as follows :—

Fowls hatched before 1928	2,598,527
Fowls hatched this year	2,825,966
Ducks hatched before 1928	154,266
Ducks hatched this year	85,336
Geese hatched before 1928 .	7,184
Geese hatched this year	16,857
Turkeys hatched before 1928 ...	14,424
Turkeys hatched this year	60,965

The returns of labour employed on farms are summarised at page 73.

Agricultural Conditions in 1928.

Weather.—The weather during January and the first half of February was to a great extent wet and stormy; frost and snow occurred at intervals, while flooding was general in low-lying areas. Towards the end of February, however, fine dry conditions prevailed throughout practically the whole country, and excellent progress was made with cultivation and other field work. In some districts the dry weather continued until the end of March, but in many areas the last two weeks of the month were cold and wet and seasonal work was retarded. During the first half of April dull and unsettled conditions were general, while night frosts were frequent and snow fell in exposed areas. For the next five or six weeks bright, dry conditions prevailed and satisfactory headway was made with cultivation, potato-planting and the sowing of seeds; growth was, however, slow owing to the low temperatures in all parts of the country. The rainfall during the earlier part of June was light, but the last ten days were unsettled. Throughout July the weather was favourable in eastern districts for both crops and live stock. In the north and west, however, cold, windy and unsettled conditions were general,

with the result that crops and pastures made little progress. During August broken weather prevailed in all districts; rain was frequent, more especially during the latter part of the month, and there was everywhere a great lack of sunshine. The showery conditions delayed the hay harvest, and in several areas a considerable proportion of the barley and oat crops was lodged; potatoes and root crops, however, benefited from the rains. In North-East Aberdeen on 1st August some damage was caused to the potato crop by frost. Harvest work was frequently interrupted during the unsettled weather at the beginning of September, but from the middle of that month until the middle of October there were no serious interruptions to farming activities and a large part of the cereal crops was secured in excellent order. The second half of October and the greater part of November were, however, unsettled in practically all districts and little autumn cultivation or other outdoor work was possible. In some western and southern areas part of the oat crop remained in stooks for three or four weeks and was more or less seriously damaged by rain, while in Stirling most of the bean crop was still out in the fields at the end of October.

Wheat.—As a consequence of the lateness of the cereal harvest in 1927 and the wet condition of the soil during the autumn months the sowing of winter wheat was protracted, and many farmers failed to get in their full breadth of seed before the end of that year. Where sown early the plants brairded satisfactorily, but, speaking generally, germination was unusually slow until the middle of February, when dry spring-like conditions favoured the development of the plants for two or three weeks. Towards the end of February considerable areas of wheat were sown under good conditions; the total area sown was, however, less than in the previous year by about 9 per cent. The growth of the plants was checked by the cold weather in April, May and June, and in many cases at the beginning of July the crop was reported to be thin on the ground. The weather was more favourable for growth during July, when there was a decided improvement in the appearance of the plants, but owing to the lack of sunshine the grain ripened slowly. Some lodging occurred during a period of broken weather in August; at the end of that month, however, the crop was reported to be standing well in most of the districts where it is principally grown. Cutting became general during the second half of September and the bulk of the crop was stacked before the beginning of October. The yield was generally satisfactory and, where the crop was grown on good soils, the grain is said to be of fair average quality; some of the spring-sown wheat was, however, cut before it was fully ripe. Very little damage was reported this season, either from disease or from insect pests.

Barley.—Seeding was carried out rather later than usual in some districts but the crop brairded well. During the early summer months, however, on damp and heavy land the plants

were reported to be lacking in vigour. As in the case of wheat, ripening was slower than usual, and in the eastern counties considerable portions of the best and heaviest crops were laid by rain. Some of the grain was ready for cutting at the end of August, but the weather was then unfavourable for a start to be made and harvest was not general until about the second week of September; the work was completed almost everywhere by the end of the third week of October, although at the close of that month in late districts there were still small portions of the crop to be cut. The grain is of good average quality and, where it was harvested before the weather became broken, it was secured in satisfactory condition. Where harvest was delayed by bad weather some of the grain is light and of mixed quality. No damage was reported from disease or insect pests. Bere, which is grown mainly in the crofting counties of Scotland, was secured in fair order and the grain is of good quality.

Oats.—The early reports on the oat crop were not quite so good as those for wheat and barley. The crop brairded fairly well in some areas, but in many districts germination and growth were rather unsatisfactory, the plants being thin on the ground and lacking in vigour. Damage by grub or wire-worm was reported from almost every district, more especially from the eastern counties. During July the outlook improved in several parts of the country. Generally speaking, where the crop was grown after lea it had a strong and healthy appearance, but where it had followed turnips, and especially on wet land, it was backward and irregular at the beginning of August. The low temperatures during the summer tended to shorten the straw and the grain ripened slowly. At the beginning of September, however, reports from the southern counties stated that in those districts there were prospects of a heavy yield of both grain and straw. Oats did not withstand the effects of the wet weather quite so well as wheat or barley, and in many cases portions of the crop were badly lodged. On most farms throughout the country harvest was in full swing by the end of September, but the unsettled weather during the second half of October seriously delayed the completion of the work, with the result that some of the crop was damaged by rain. In several western areas the grain is of unusually good quality except in those cases where a proportion of the crop had to be cut green. Elsewhere the quality of the grain is generally up to the average, but a considerable amount of the crop was secured in an unripe condition and several complaints have been received of heating in the stack.

Beans.—The sowing of beans was delayed by unfavourable weather and at first the crop was rather backward in growth. At the beginning of August, however, the plants were reported to have a promising appearance; in Stirling, which is the principal district for this crop, the plants were then said to be healthy and flowering vigorously. For the remainder of the season the weather conditions were fairly suitable for this crop, and in most

cases the plants podded well with a fair length of straw. No reports were received of damage by disease or insect pests, but a small proportion of the crop was secured under unsatisfactory conditions.

Potatoes.—Very little progress was made with the planting of early varieties of potatoes before the month of March, while in several districts the planting of maincrop varieties was delayed until the end of May. Growth was slow during June and July, and at the beginning of August some of the haulms were rather stunted and backward as a result of the cold weather. The general condition of the crop showed considerable improvement during the following months, however, and although the proportion of the total acreage reported to have been sprayed was almost negligible, there were remarkably few complaints of disease or damage by blight. Estimates of the yield and quality of the tubers are satisfactory generally, and in some western areas the crop was said to be the best harvested for some years. At the end of October about three-quarters of the crop had been lifted; some of the tubers harvested during the last few days of that month and the first half of November were, however, secured under unfavourable conditions.

Turnips.—The sowing of turnips and swedes was completed in fair order, but the braird was at first rather irregular owing to the dry condition of the soil during May. Where sown late the braird was stronger and the plants made good progress despite the cold weather. Singling was fairly well advanced at the end of June and some progress had been made with the hoeing of the crop in several districts. The reports on the crop improved steadily as the summer advanced, but at the end of July complaints of "finger-and-toe" were received from a number of eastern counties, and weeds were stated to be unusually troublesome in a few of the south-western areas. The frequent spells of mild unsettled weather during August, September and October were particularly favourable for the growth of roots, and in most districts turnips developed into a sound bulky crop of good quality; the roots were still growing at the beginning of November.

Mangolds did not grow so well as turnips, and at the end of October the prospects for the crop were rather disappointing in some areas. No reports of damage by disease or insect pests were received during the growing season.

Sugar Beet was sown on a much smaller scale than in 1927. In some districts, such as the Lothians and North-East Angus, the roots developed somewhat better than last year, and the latest reports received indicated that there were prospects of a fairly good yield. Elsewhere it would seem that the low temperatures during June and July had a more serious effect upon this crop than upon turnips and swedes and in many cases the roots became stunted, while a considerable number of the plants ran to seed. The lifting of the crop began in a few cases before the end of October, but the work was rendered rather difficult

owing to the wet condition of the soil; at the beginning of December the roots were being delivered to the factory.

"Seeds" Hay.—In the autumn of 1927 some damage was caused to the young grasses by the lodging of the cereal crops and by flooding. At the beginning of May, however, rye-grass and clover seeds were generally reported to be strong and vigorous, although growth had been somewhat checked by the cold weather experienced during the early spring months. During June the crop matured slowly, and when cutting became general in July it was obvious that the yield would be fully 5 per cent. below the average; clover was scarce in several districts. Most of the crop was secured under very satisfactory conditions and the general quality of the hay was exceptionally good.

Meadow Hay.—The yield of meadow hay varied in different localities, but in most cases it was rather heavier than that of "seeds" hay, while in several districts the yield was a full average. Much of the crop was secured in good order, but in some areas harvest was protracted owing to broken weather, and a considerable proportion of the hay was damaged by rain before it was put into ricks; in a few late districts the crop had not all been secured at the end of October.

Cultivation.—At the end of October ploughing was fairly well forward in the Lothians, Inverness, Ross and Cromarty, Moray and parts of Aberdeen, but elsewhere little progress had been made with this work. The weather during November was more or less unsettled in all parts of the country and there were few opportunities for overtaking arrears; some progress had, however, been made with the ploughing of lea. The sowing of wheat was well advanced at the beginning of December in Moray, Angus, South-West Fife, the Lothians and a few other districts, but speaking generally the work had made slow progress; some of the seed was sown in rather bad order.

Live Stock.—Feeding cattle are generally reported to be in fairly good condition; in some of the south-western counties, however, the wet, stormy weather during November affected the condition of the stock and they are said to be leaner than is usual at this period. Dairy cows have thriven fairly well despite the unfavourable weather during the last few months. The milk yield has shewn the usual seasonal falling off, but in Perth the supply has been somewhat below the average even for the season. The reports on sheep are varied. In some eastern districts both lowland and hill flocks have done very well during the autumn, but in several of the south-western areas the sheep have suffered from the effects of the wet weather and have lost condition. Taken on the whole, however, the mild open weather in November was fairly satisfactory for the flocks, and pastures generally continued fresh. The supplies of winter keep are sufficient for requirements and of good quality.

Labour.—The supply of regular and casual workers is generally ample for present needs. In Dumbarton and Renfrew, however, there is a scarcity of experienced dairy workers.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

The Significance of Variety in Oats with respect to Yield and other Ancillary Characters under North Wales Conditions. *By R. Alun Roberts, B.Sc., Ph.D., University College, Bangor.* (*Welsh Journal of Agriculture, Volume* 4.)—Black oats and yellow oats are grown extensively in North Wales. Many enterprising farmers, who have tried white varieties, still continue to grow the other varieties, particularly in upland districts where there is a high rainfall.

Victory and Record have proved the most suitable white oats for the lowland districts of North Wales. In some years the one variety did better than the other, but over a number of years there was no great difference between them as regards weight of grain and straw. Record has stronger straw than Victory, and in wet seasons has stood up when Victory has lodged. King and Crown have given good yields, but there seemed to be no reason to recommend either on the score of yield in preference to Record and Victory. King was decidedly later in ripening. Wide-Awake produced high-quality grain combined with a good yield. Yielder did not give particularly good results, but it seemed suitable for strong soils in later districts. Varieties of the Potato oat always gave late-ripening crops with a high yield of straw and a low yield of grain. Golden Rain is a variety equally hardy with Goldfinder and otherwise similar to it, and, on account of its earliness, could be commended to upland farmers in preference to Goldfinder. Golden Rain should be cut before it is dead ripe. Bountiful was superior to Black Tartarian for good lowland conditions in North Wales. Bountiful is earlier in ripening, strong and long in the straw, but the grain is rather easily shed at harvest. Supreme gave satisfactory grain yields and ripened early, but has weak though rather coarse straw.

The Technique of producing Elite Stocks of Normally Self-fertilised Grain Crops. *By W. T. G. Wiener* (*Scientific Agriculture, No.* 9.)—Elite Stock seed in Canada is defined as seed which is 99·995 per cent. pure as to variety. For the production of Elite Stocks of seeds from normally self-fertilised crops three general methods of procedure are at present recognised :-

(*a*) Mass selection of heads, spikes, or panicles.

(*b*) Individual plant selection.

(*c*) Mass selection with the plant as a unit of selection.

Mass selection of heads as a procedure in the development of Elite Stocks of seed is the most primitive of the three methods. The writer is inclined to agree with those who would eliminate the method as a means of developing Elite Stocks of cereal grains.

Single plant selection is the antithesis of mass selection of heads. In the hands of a trained grower or plant breeder this method has marked possibilities in the matter of improving crops. There is no question that by the selection of single plant lines, especially those exhibiting a very high degree of uniformity, very consistent strains may be obtained.

Seeds Mixture Problems: Competition. *By R. G. Stapledon, M.A., and Wm. Davies, M.Sc.* (*Bulletin No. 8, Series H, Welsh Plant Breeding Station.*)—The bulletin on Competition as a Seeds Mixture Problem issued by the Welsh Plant Breeding Station deals with an extensive series of experiments and trials carried out during the last eight years, and the results of these investigations yield a considerable amount of information which should be of value to both the farmer and the scientific worker.

The species and strains of herbage plants dealt with are grouped according to their potential aggressiveness as follows :—

A. *Aggressors.*—

(1) *Aggressive in the seeding year.*—Italian ryegrass, perennial ryegrass, tall oatgrass, broad red clover, cocksfoot, late-flowering red clover.

(2) *Aggressive in first harvest year.*—Italian ryegrass, perennial ryegrass, tall oatgrass, late-flowering red clover, broad red clover and cocksfoot.

(3) *Aggressive in the aftermath.*—Italian ryegrass, cocksfoot, broad red clover, late-flowering red clover, tall oat grass.

(4) *Aggressive in pastures.*—Rough-stalked meadow grass, bent, wild white clover, crested dogstail, Yorkshire fog, suckling clover.

B. *Generally Non-aggressors.*—

(1) Able to withstand some competition in the first harvest year, or at least to make good recovery in later years :—

(a) *Recovery by re-seeding.*—Subterranean clover, crested dogstail, sweet vernal grass, Yorkshire fog.

(b) *Recovery by Vegetative propagation.*—Rough-stalked meadow grass, meadow foxtail, wild white clover, tall fescue, smooth-stalked meadow grass, red fescue.

(2) Unable to withstand keen competition and to make recovery in later years :—Meadow fescue, timothy, birds' foot trefoil, alsike, sheep's fescue.

Competition in seeds mixtures where hay is taken is due to shading, and the most aggressive species are those which can shade and thereby weaken and kill off plants of other species. The unsuccessful competitor is one which does not tend to harm other species to any marked degree and which cannot itself withstand excessive shading. Root competition does not seem to be a factor of prime importance in relation to seeds mixtures except possibly on poor soils and under the poorest conditions generally.

Speaking broadly, grasses compared with clovers are the aggressor species, largely due to the fact that most grasses start growth earlier in the spring than do the clovers. Broad red clover is the aggressor compared with late-flowering red in the seeding year, but during the hay year late-flowering becomes the aggressor, and again, good stands of broad red clover are aggressive to extra late red clover (e.g. Montgomery) in the first harvest year aftermath. All the larger clovers are aggressors in relation to wild white clover. Competition between species is influenced very greatly by the methods of management, as everything depends on whether the aggressor species are allowed to develop unhampered.

The bulletin concludes with a discussion of the compounding of seeds mixtures for various purposes.

Government Certification of Seed Potatoes in New Zealand. *J. W. Hadfield, New Zealand Journal of Agriculture, Wellington, 1927, Vol. XXV, No. 2.*—The Fields Division of the New Zealand Department of Agriculture has arranged to initiate a system of certification of seed potatoes within the Provincial District of Canterbury during the season 1927-28. If the scheme receives due support from growers, merchants and seedsmen, it is intended to extend it in succeeding years to embrace the whole of the Dominion. For the first year's operations 19 varieties have been selected for certification. The inspections of crops will take place in January, just prior to the shaws maturing, and after harvest, when the tubers have been graded and are in sacks. Standards will be set during January of each year. Growers of certified seed will be registered.

SOILS.

Distribution of Nitrate in Three Layers of Fallow Soil. *John B. Smith, Rhode Island Agricultural Experimental Station, Soil Science 26, 5, 347 (1928).*—An experiment is described which was designed during the summer of 1926 to study the distribution of nitrate among three layers of fallow soil.

Samples of a soil which had been treated with an easily nitrifiable fertiliser were drawn at intervals during the months of June to November from the surface 7 inches, the second 7 inches, and the next 10 inches, and examined immediately for nitrate content. The results indicate that there is little actual loss of easily nitrifiable nitrogen throughout the season from the two feet of soil examined. Weather conditions and micro-organism activity, however, caused decided variation in the nitrate content of the different layers. After heavy rain the figure for the surface layer fell considerably, but the nitrate was often retained in the lower layers as indicated by a rise in this figure. This nitrate was returned to the surface layer under mid-summer conditions by the upward movement of soil water.

During a dry period in September loss of nitrate was observed from the surface

layer, and this is attributed to the ascendancy of forms of micro-organisms which assimilate nitrate. Although during late autumn the nitrate content of the soil as a whole increased, the content of the surface layer fell to a very low figure.

ANIMAL BREEDING.

General.

Selection for Meat Production. *By John Hammond.* 1928. *Zeitschrift fur induktive Abstammungsund Vererbungslehre.*—This is a continuation of the excellent work which is being done by Mr. Hammond at Cambridge University of which notes have already appeared in these columns. (See *Scottish Journal of Agriculture*, July 1927.) The following points will be of interest.

Just as size is a quantitative character and changes with age, so also do the proportions of the body; for example a leg of mutton taken from a Suffolk lamb at birth has a higher proportion of bone to muscle than one of five months old and still higher than one in adult life. Similarly at birth the cannon bone (metatarsal) is relatively well developed and grows least after birth, while the upper bone of the leg—the femur—grows most. The muscles after birth grow to an even greater extent than the bones they surround, so that the proportion of muscle to bone increases with age while the ratio of fat to bone increases still further. Early maturity from a meat point of view means not only weight-for-age, but also a quick change in the proportions of the parts; thus a leg of mutton from the early maturing Southdown breed at five months old shows a high proportion of muscle and fat to bone, whereas the leg of the later maturing Lincoln breed at the same age (and of rather greater actual weight) shows a low proportion of muscle and fat to bone.

It will be inferred that the evolution of the proportions in the British type of meat-producing animal has probably been brought about by gradual changes rather than large mutations—by forcing the animals to grow and by selecting those which develop best, thus getting accumulations of slight variations along the same line in development, associated with which is the correlation between parts having the same time of growth. It is not surprising therefore to find that where the inheritance of these or similar characters have been studied, they have been found to be of the multiple factor or blending kind. It would appear not unlikely that they are so multiple as to be for all practical purposes continuous variations, as in fact the character itself is during the life of the animal, in continuous change. If this is so, looking for discontinuous segregation in the F_2 generations is a hopeless task in the practical breeding of farm animals, as the chances of finding the desired combination are many times less than the total number of offspring it is possible to produce. In place of this method, therefore, we would suggest selection in the optimum environment, not only as regards nutrition, but also as regards other conditions such as management, particularly basing the selection on the sex in which the character is exhibited to fullest extent—for meat the male, for milk and fertility the female—followed by inbreeding to the parent in which the character is most pronounced.

Cattle.

The Present Status of Cattle and Beef. *Armour's Monthly Letter, Vol. 9, No. 4,* 1928.—Prior to the World War there has been a duty on cattle and beef imported into U.S.A. for a long time, with the exception of the years 1894 to 1897. Until 1905 the United States virtually dominated the export trade in good type beef and well-finished live cattle.

In the eight years beginning with 1907 there was not only a sweeping decline in American exports of cattle and beef, but a brief swing to an import basis. This was due chiefly to a rapid spread of homesteading into areas previously devoted largely to beef cattle. Several years of short pasture crops, feed crops, or both, accentuated this trend.

There was a net change in the beef status of the United States of 1,064,000,000 lbs. between 1907 and 1914, i.e. from net exports of 602,733,000 lbs. to net imports of 461,271,000 lbs. As a result of this change the world situation reacted sharply—Argentina, Uruguay, Australia, New Zealand, and Canada increased their exports of dressed beef and beef equivalent of live cattle between 1910 and 1914 from approximately 1,100,000,000 lbs. to nearly 1,600,000,000 lbs.

During the post-war period, the situation has been one in which a country which had had a highly protected market, but had just lost it in a period of striking readjustment and universal downward price trends, regained protection and denied free entry to a neighbour that had formerly shared the protected market. This neighbour (Canada), therefore, had to follow the downward world trend in prices in the marketing of her cattle surplus after May 27, 1921. In the last seven

months of that year as compared with the first five months Toronto prices for good beef steers averaged $2·14 lower, as compared with a decline of only 35 cents at Chicago for native beef steers.

At the present time American cattle breeders are in a very favourable position after five years of severe stress. In 1927 range cattle at Chicago averaged $10·50 per 100 lbs. during August to December, inclusive, as compared with approximately $6·40 during the like period of 1921 to 1924. Stocker and feeder cattle during this part of 1927, the season of heaviest marketing, averaged $8·95 per 100 lbs. as compared with $6·05 during the like season of 1921 to 1924. This is a seasonal advance of more than 60 per cent. in average prices for range cattle, and of nearly 50 per cent. in average prices for stockers and feeders. This seasonal advance means a sweeping change in the economic position of cattle breeders (as stated in the Monthly Letter for December 1927), and they should be in a strong position until at least 1931.

The "Proved" Sire in Dairy Improvement. *Jour. Hered., Vol.* 19, *page* 520. 1928.—A factor of great importance in the building up of a dairy herd is the use of a good proved bull, says O. E. Reed, Chief of the Bureau of Dairy Industry, United States Department of Agriculture.

To prove a bull, according to the standards set by the bureau, it is necessary to compare the yearly records of at least his first five daughters with the records of their dams. Such a comparison indicates the probable value of a bull to a herd.

The record of one outstanding sire that was proved in a Vermont dairy-herd-improvement association was pointed out. The first reports received of this bull included records of 15 daughters and their dams. The dams were, without exception, much better than the average dairy cows of this country, their average of butterfat being 386 lbs. The 15 daughters of this sire, however, averaged 545 lbs. of butterfat. Here was an average gain of 159 lbs. of butterfat, or more than 40 per cent. Even more remarkable, every one of the 15 daughters was a better producer than her dam. The sire is to be credited with most of the improvement. He possessed to a remarkable degree what is known as "prepotence" in milk production.

Proved bulls whose records are bad should be slaughtered, but the prepotent bulls that have demonstrated their ability to sire daughters more productive than their dams should be kept as long as they are useful.

International Trade in Mutton and Lamb. *Armour's Monthly Letter, Vol* 9, *No.* 8. 1928.—At the present day a comparison of sheep-producing countries with those which have normally been considered good markets for lamb and mutton indicates that the per capita use of this meat has declined much more greatly among producers than among consumers. For example, Australia has dropped from 97·5 lbs. in the pre-war years to 54·7 lbs. in 1925, a decrease of nearly one-half. Similarly, Argentina decreased from 32·2 lbs. in the pre-war period to 20·2 lbs. in 1927, a decrease of over one-third.

On the other hand, the United Kingdom, which is the heaviest lamb-consuming country, shows only a minor decrease from 29·3 to 24·9 lbs. In the last three years both Canada and the United States have shown very slight increases in per capita lamb consumption, while Germany and Belgium have held fairly steady. Nevertheless, German lamb consumption in 1927 was approximately 31 per cent. below the pre-war level. This decrease is of minor importance internationally, as neither Germany nor France have been important figures in the international lamb and mutton trade at any time.

The total consumption of mutton and lamb in 1927 in Great Britain was 8·4 per cent. under the pre-war level, while the per capita consumption was some 15 per cent. beneath it. To a certain extent this decline in lamb has been replaced by an increase in pork, total pork consumption in Great Britain having risen nearly 22 per cent. as compared to pre-war. During most of the post-war years the imports of lamb and mutton of Great Britain have exceeded those of 1913, but several factors have served to keep down the per capita consumption. Among these factors may be noted the growth in population, the decline in domestic production, and the unemployment situation, which has lessened the purchasing power of the British people. Perhaps a direct factor is the relative price of mutton and lambs as compared to pork. This factor has been of importance in the competition of beef and pork for public favour in the United States. First quality British pork always brings lower prices per pound than does domestic fresh lamb, while grade for grade American pork always undersells corresponding qualities of beef. In fact the frozen mutton and lamb in

Great Britain, on which the bulk of the trade is based, often bring approximately the same price per pound as the best British pork, and seldom sell very far under it. The principal sources of frozen mutton and lamb for the British market are New Zealand, Argentina and Australia respectively.

Per capita consumption of lamb has decreased in practically all countries throughout the world. Covering a long period in the United States the per capita consumption of lamb was 6·8 lbs. in 1900, while in 1912 it averaged 8·1 lbs. Since the war it has ranged between five and six lbs., never quite attaining the latter figure. This trend in lamb consumption is quite significant if only the United States were taken into consideration.

The sheep industry in U.S.A. is now approaching the volume of production which prevailed around 1910, but the important difference in the situation is the continually increasing price level due to the growing demand of consumers. In other words, the last few years have seen increasing quantities of lamb and mutton consumed at higher prices, due to the increased proportion of lamb as compared to mutton in the market offerings, and the improved quality and desirability of the resulting meat. As a matter of fact the number of sheep and lambs in the United States at present is the largest in sixteen years. In spite of this favourable outlook, when the facts presented in the foregoing table are taken into consideration, the decrease in lamb consumption becomes a factor of first importance.

At the present time the immediate economic situation in the United States looks bright for the consumption of mutton and lamb. On a comparative basis pork and beef are higher in price than mutton and lamb, and are likely to continue so in view of the present condition of supply of cattle and hogs. Furthermore, recent reports from the U.S. Department of Agriculture indicate that the number of chickens being raised on farms in 1928 is 10 per cent. less than 1927. This means undoubtedly that prices for poultry will be considerably higher, and lamb will have an advantage in relation to poultry meat also.

In fact the sheep industry is in one of its most profitable periods. The industry is on the upward swing of the production cycle, and prices have failed to show the recession which has always characterized expansion in the past. This can be explained only by growing demand, undoubtedly stimulated by the campaigns in favour of this meat, but successful only because of the improvement in quality and desirability of lamb as a food. It must be realised, however, that the Argentine population is increasing rapidly, indicating an increased capacity for consuming mutton and lamb. Increased consumption will follow naturally if price factors are favourable to the consumer in relation to other meat prices. The same comment is true of Australia. Its population has been increasing fast enough to consume more mutton and lamb in the long run. Furthermore, Australia has a climatic governor—periodic drought—on its sheep population increase. There is a certain point beyond which the sheep population cannot go because of the drought which occurs on an average every three years. New Zealand has now reached the top, or nearly so, of its sheep population. It can probably increase sheep somewhat, but at the present time there is a tendency in New Zealand for farmers to go in for beef cattle and dairying.

Pigs

Exhibiting of Breeding Pigs. I. *W. Seedorf, Deutsche Landwirtschaftliche Tierzucht, Vol.* 32, *No.* 3. *Hannover*, 1928. II. *Golf, Ibid.* III. *W. Seedorf, Ibid., No.* 5.—In a discussion between Prof. Seedorf and Prof. Golf on pig breeding the former condemns the present exhibition system. He says that the unreasonable fattening of the most valuable breeders for show purposes is a curse to pig breeding, for, besides the heavy loss of capital in wasted food, this fattening and subsequent thinning process after the show are seriously prejudicial to the best and most promising breeders. Prof. Seedorf holds that judges should insist that fat animals should not be the only ones exhibited, and that medals ought to be given only to those having true breeding characteristics, since there are already exhibitions of fatted animals.

Prof. Golf denies that shows have such an unfortunate influence on breeding in spite of the number of overfed animals often exhibited. He quotes figures to show that animals which have received a 1st or 2nd prize cannot possibly have been in such an over-fat condition that their value for breeding purposes was diminished, seeing that they have since proved to be good breeders.

In his conclusion Prof. Seedorf continues his argument and says that he has made some proposals to the Breeding Division of the "Deutsche Landwirtschafts Gesellschaft" (D.L.G.), suggesting among other things that the exhibitions of fatted animals be used also for breeding animals (which the D.L.G. declares absolutely necessary), and that all the societies of breeders for meat production

should participate in these shows on exactly the same footing as those breeding for reproductive purposes Finally he proposes that the D L G should no longer admit for competition among breeding animals those which by reason of being fatted for show purposes are not in condition for reproduction

Poultry

The Inheritance of Resistance to Fowl Typhoid in Chickens. *By W V Lambert and C W Knox* 1928 *Iowa State College Journal of Science, Vol 2, pp* 179 187 —In this paper the writers are reporting the preliminary phases of an investigation begun with the purpose of attempting to determine whether or not it would be possible by selection to increase the resistance of chickens to fowl typhoid The term resistance rather than immunity is used, for it is probable that no animal is completely immune to any disease However, it seems probable that various degrees of resistance toward a given infection exist, and, if so, it should be possible by selection to produce a strain of fowls having a high natural resistance

A total of 1,305 chicks were tested with the fowl typhoid organism Of these chicks 410 were descendants of parents that had both survived an acute infection of fowl typhoid Of this group 168 or 40 9 per cent died Another group of 202 chicks, that had as parents a typhoid surviving male mated with non tested females, gave a mortality of 62 4 per cent Both of the above groups were Single Comb White Leghorns

All other birds used were from parents not having been tested with the fowl typhoid organism Of this group 405 were White Leghorns bred similarly to those above Three hundred and fifty nine or 88 6 per cent of them died A second group of 104 Rhode Island Reds showed a mortality of 98 1 per cent A third lot of 104 chicks, descendants of White Leghorn males mated with Rhode Island Red females, gave a mortality of 85 6 per cent A group of 80 White Plymouth Rock chicks gave a mortality of 82 5 per cent

An interesting point to be observed is that the difference between the various breeds are significant Such differences however, are probably not representative of the breeds as a whole, but more likely represent strain differences within breeds More information on this point is desirable

It is interesting to note in this connection also, that the chicks from the Rhode Island x White Leghorn cross are slightly more resistant than the White Leghorn chicks and much more resistant than the Rhode Island Red chicks This would seem to indicate a dominance of the factors for resistance carried by the White Leghorn, and likewise, to indicate that the Rhode Island Red may carry factors for resistance that the White Leghorn lacks

Relationship between Body Weight and Egg Production in the Domestic Fowl. *by C S Platt Poultry Science Vol 6, pp.* 285 289 —The records of 435 White Leghorns in the First International Egg Laying Contest at Vineland, N J, were used as a basis for this study The year was divided into three seasons winter, spring, and summer fall and the weights of the birds during these seasons were compared with the production The body weight during the year was also compared with the annual production during both the pullet and the yearling years

There was a positive correlation between the body weight in the spring of the pullet year and the production during this season and a negative correlation between the maximum body weight in the yearling year and the total production for that year The data revealed that birds weighing from 4 to 4 5 lbs during the pullet year may be expected to produce the greatest number of eggs Any weight in excess of this is detrimental to yearly production, even though favourable to production during the winter and spring seasons The optimum weight during the yearling year was found to be approximately 4 lbs indicating a greater tolerance for excess weight during the pullet year than during the yearling year

Preservation of Eggs. *J Schuessler Deutsche Landwirtschaftliche Geflugel zeitung, Berlin*, 1928 *Jg* 31, *Nr* 24 —The writer has proved that the lecithin content of eggs rapidly decreases, and consequently a new laid egg has a higher nutritive value than an egg 10 days old and much higher than one which has been preserved in lime for months Even if a preserved egg has still its full food value, compared with a fresh egg it is an unbalanced food The changes an egg undergoes are due to (1) fertilisation, (2) exchange of gases through the porous shell, (3) penetration of micro organisms For satisfactory preservation, then, it is essential to use unfertilised eggs, to prevent interchange of gases and, above all, the penetration of putrefactive bacteria The use of liquid preservatives

for eggs is therefore totally inadequate, because they facilitate the penetration of bacteria and originate chemical decomposition. The writer advises the use of dry preservatives, such as "Cellonlack," which is sterile, makes a poor medium for bacterial growth, and on account of allowing the passage of the most active ultra-violet rays makes any bacterial development impossible. On the other hand it makes a hard, glassy coating to the egg which conserves its air and moisture. Good results were also obtained with "Zaponlack." Eggs for preserving should first be thoroughly washed with a clean brush, then rapidly dried on a large-meshed wire gauze. The eggs are then immersed in a dilute solution of lac and allowed to dry again in the air, which quickly hardens the lac. After this treatment the eggs should be kept in as light a room as possible, but not exposed to direct sunlight.

ANIMAL NUTRITION.

Some Preliminary Experiments on the Value of Small Quantities of Whole Cows' Milk when fed to Pigs. *A. H. Blissett and J. Golding. J. Agr. Sci., XVIII,* October 1928.—In previous pig-feeding experiments the authors had observed that the addition of small quantities of whole milk to a pig's ration, even although this ration was a well-balanced one, had a beneficial influence on rate of growth. In this paper the results of four experiments are described in which 25 pigs were fed on a ration containing half a pint of milk. Eighteen were fed on control rations generally considered to be adequate, and of which, in one series, dried separated milk was a constituent.

In every experiment the fresh milk produced an increase in live weight over the controls, varying from 8 to 10 per cent. Less dry matter per pound increase in live weight was consumed by the experimental pigs than by the controls. The authors conclude that this supports Woodman's contention that milk "may have a specific action in increasing the extent to which a given foodstuff is digested."

Digestibility Trials with Poultry. *E. T. Halnan. J. Agr. Sci., XVIII, October* 1928.—IV. *The Digestibility of Certain Varieties of Oats.*—Digestibility trials with oats, carried out with White Leghorn cockerels, indicate that certain varieties of oats are more suitable as sources of food nutrients for poultry than others. Grey Winter oats proved more suitable than Black Bountiful or Scotch Potato oats for poultry feeding. The suitability of varieties of oats for poultry feeding appears to be linked with the fibre content, and thin husked varieties appear to be most suitable for this purpose.

V. *The Digestibility and Feeding Value of Bulrush Millet.*—Palatability tests with bulrush millet indicated that this grain of Empire origin is in every way suitable as a food grain for poultry in all stages of growth. Digestibility trials have proved that this grain is readily digested by poultry. Bulrush millet, on a digestibility and composition basis, appears to approximate in feeding value to Little Joss wheat.

VI. *On the Influence of the size of a Ration upon its Digestibility.*—Four White Leghorn cockerels were fed with widely varying quantities of a Sussex ground oats and milk mixture without material alteration in the coefficients of digestibility of the digestible material. The amounts fed varied from a sub-maintenance ration of 50 gm. to a "limit of appetite" ration of 150 gm. A slight depression in the coefficients of digestibility of the organic matter, the crude protein and the N-free extract, and a slight increase in the coefficient of digestibility of the ether extract and a slight increase in differences shown are attributed to normal fluctuations in digestibility due to individual variation and not to differences in the quantity of food given. In feeding experiments carried out with fowls, in which variable amounts of food are fed, these experiments indicate that it may safely be assumed that the coefficients of digestibility of the food nutrients are not materially affected by the variations in the amounts of food fed.

Trial on the Feeding of Jerusalem Artichokes to Pigs. *K. W. D. Campbell. Reading Univ. Bul.,* 35, 1927. *(E.S.R., October* 1928.)—The results of two trials on the feeding of Jerusalem artichokes to pigs at the University of Reading, England, are reported. In trial 1. three lots of five pigs, each averaging approximately 130 lbs., were fed the following rations per head daily: Lot 1, meal mixture 5 lbs.; lot 2, meal mixture 4 lbs. and artichokes 4 lbs.; and lot 3, meal mixture 4 lbs. and artichokes *ad libitum.* In the second trial similar pigs were fed as follows: lot 1, meal 3·5 lbs.; 2, meal 3·5 lbs. and artichokes *ad libitum*; and lot 3, unlimited meal and artichokes *ad libitum.* The meal

mixture used consisted of barley meal, middlings, bean meal and fish meal, 60 : 30 : 5 : 5 parts. In trial 1 the pigs harvesting the artichokes consumed approximately 10 lbs. per head daily, and in trial 2 from 7 to 8 lbs. daily.

The addition of 4 lbs. of artichokes in place of 1 lb. of meal to the ration in the first trial resulted in the pigs gaining 12·8 lbs. less than those receiving no artichokes. In the second trial the pigs harvesting the artichokes gained approximately the same as those receiving no artichokes, indicating that this root crop furnished approximately enough nutritive matter to counterbalance the extra work done by the pigs in rooting. Pigs receiving about 10 lbs. of artichokes made 14·2 lbs. more gain than those receiving 4 lbs., indicating that it required approximately 10 lbs. of artichokes to replace 1 lb. of meal.

DAIRYING.

Bean Meal for Dairy Cows. *A. C. M'Candlish. West of Scot. Agr. Col. Bul.* 112. *Sept.* 1928.—This contains a report of feeding trials with meals from home, China, Sicilian and white Rangoon beans. The meals were found to be of about equal value for the feeding of dairy cows. In addition a review of work on the subject is included. It is concluded that as a concentrate for dairy cows bean meal is quite good, but it is frequently too high-priced to be economical. Where only one concentrate is to be fed there is probably nothing much better than bean meal, though generally a mixture can be made up which will be more economical than bean meal alone.

Rearing Dairy Calves. *A. C. M'Candlish. West of Scot. Agr. Col. Bul.* 113. *Sept.* 1928.—The rearing of dairy heifers from birth to producing age is discussed. General management is considered, but most attention is given to feeding. The main factor in determining the system of rearing calves to be adopted in any particular case is the supply of milk or of dairy by-products available. Rations are given to suit these varying conditions.

High Protein Grains as a supplement to Pasture for Dairy Cows. *C. C. Hayden and A. E. Perkins. Oh. Sta. Bimo. Bul., Vol.* 13, *No.* 3, *pp.* 99-102. 1928.—A ration containing 2 parts maize, 1 part maize and 1 part wheat bran was compared with one containing the same constituents with the addition of 1 part linseed oil meal and 1 part maize gluten meal as supplements for cows on pasture. The high protein mixture contained 16·8 per cent. of digestible protein as compared with 9·3 per cent. in the first. Owing to the lowered cost and the failure of the high protein ration to increase production, it was concluded that the low protein mixture was the most economical.

A new milk-borne Disease: Undulant Fever. *Science* 68, *No.* 1744, *p.* 14.—According to M'Alpine of the Storrs Agricultural Experiment Station and Lee Michle of the Connecticut Department of Health, milk and milk products are probably the source of undulant fever, a new disease that is becoming more prevalent in U.S.A. Cattle of all kinds may be affected with the germ of the disease. In countries around the Mediterranean goats carry the germs, but in America it has been traced to cows, where it appears as infectious abortion. When human beings drink the raw milk from such infected cows they may get the human form of the disease, undulant fever. However, cows are infected with two kinds of the *Bacteriam abortus*, the germ causing abortion. Probably only one of these is capable of producing undulant fever in the human being. This is suggested as the reason why not every person drinking infected cow's milk contracts the malady.

Soya Beans: Effect on Flavour of Milk and Butter. *W. B. Nevens and P. H. Tracy. Journal of Dairy Science,* II (6), 488.—Ground soya beans have no effect on the flavour of milk, but they have quite a marked effect on the body of butter, causing it to become somewhat gummy, a condition which becomes more pronounced as the proportion of soya beans in the ration is increased.

Cleaning of Milk Plants. *Science* 68, *No.* 1768, *p.* 14.—Ordinary methods of cleaning sometimes leave a rough deposit known as milk stone on tanks, pipe lines, pasteurisers and other equipment. This occurs even when the washing compound used has the power of killing germs. Failure to clean utensils properly is the weakness of many washing compounds in general use. Results of recent experiments indicate that tri-sodium phosphate is the most satisfactory cleanser. It should not, however, be mixed with carbonate or bicarbonate of soda.

Destruction of Botulism Toxin by Milk Bacteria. *J. M. Sherman, C. N. Stark and P. Stark. Journal of Dairy Science*, II (5), 352.—It has been shown that certain bacteria commonly found in milk have the power of destroying toxin formed by *Bacillus botulinus*—the causal agent in a certain form of "meat poisoning." This probably explains why milk and dairy products are seldom if ever agents in the dissemination of botulism. The fact that the common lactic acid germs, *Streptococcus lactis* and *B. casei*, have the power to destroy botulism toxin is of particular interest in connection with cheese, since in most types of cheese the former is the predominating organism during the early stages of ripening, while the latter is one of the predominating organisms in all types of cheese during the later stages of ripening.

A Defect in Milk due to the Action of Light. *William C. Frazier. Journal of Dairy Science*, II (5), 375.—The so-called "carboard taste" and "linseed-oil" odour develop in whole milk which has been exposed to diffuse daylight for eight hours or more at about freezing temperature. The light apparently acts as a catalyst in the oxidation of the milk fat. The defect develops more rapidly in pasteurised than in raw milk. The presence of neither enzymes nor bacteria is necessary for the reaction.

Fat or Butter Content as an International Standard of the Yield of Dairy Cows. *Richardson. Deutsche Landwirtschaftliche Tierzucht*, Hannover, 1928, Jg. 32, No 15.—The author draws attention to the confusion caused by the continued use in literature of different units for measuring the lactation yield and fat yield of a cow Some figures are expressed in kilogrammes, some in litres and some in pounds; and besides, to express the yield of a cow its yield of fat is often given as well as, or instead of, its yield of butter.

He notes that this makes comparison difficult between data from different cows and proposes the selection of uniform units of measure to be used internationally for the determination of lactation yield. He proposes that in the German technical press results should be expressed in the unit already generally used, i.e. the kilogramme, to which foreign units should be reduced when they refer to relevant data from other countries. The absolute yield of the dairy cow might be expressed internationally by the fat content of milk, obtained by multiplying the milk produced by its fat content. The name and measure "butter fat" or "butter-content" ought to be definitely discarded.

Disadvantages of Milking with the Thumb. *F. Haemmerle. Süddeutsche Molkereizeitung, Kempten im Allgäu*, 1928, *Jg.* 49, *No* 3. -By milking with the thumb a much greater mechanical stimulus is exercised on the teat than in any other method of milking Not only do the corns formed on the thumbs of most milkers who use this method cause much pain to the cows, but they also cause internal injuries to the teat. Normally the mucous membrane of the teat is composed of two rows of cells. Milking with the thumb or too vigorous drawing of the teat causes the formation of new layers of cells in the mucous, which may attain as much as 40 times its initial thickness and become more or less hardened. The thickenings, often as large as peas, are formed mostly in the inner folds of the teat. Some of these proliferations of the mucous membrane are torn during milking or become naturally detached from the parts of the tissue which often obstruct the secretory tract. The author compared the teats of cows from districts where milking with the thumb is practised with those from countries where the right method, with the whole hand, is used. He was able to show conclusively that with the former method thickenings in the teats are more frequent and larger than where the whole hand is used.

INSECTS AND PESTS.

Apple Maggots. -The gnawing canker at the heart of the apple apparently disturbs others that the eater who comes unexpectedly upon the grub, for a considerable investigation has been devoted to it by the U.S. Department of Agriculture in the interests of American orchard farmers (*Tech. Bull No.* 66, 1928). The apple maggot is the juvenile stage of a Trypetid fly (*Rhagoletis pomonella*)—a true-born native of America. In its unsophisticated state it fed upon hawthorn berries and other wild fruits, but about 75 years ago the growing abundance of cultivated apples induced it to try the new fruit, which it has found to be so much to its taste that the maggot has now become one of the most serious of apple pests in the north-eastern part of the United States and in south-eastern Canada. As well as attacking haws and apples, it sometimes attacks pears, plums and cherries. A careful account is given of the life-history

of this pest, and observations have been made as to the natural enemies which might be of service in reducing its numbers. On the whole, however, it would seem that parasites and predators have very little practical effect upon the great numbers of apple flies. Experiments have shown that the best means of control is the use of a solution of commercial powdered arsenate of lead, 1 to 1½ lbs. to 50 gallons of water, used in two applications and applied as for the codling moth. Dropped infested apples should be gathered twice a week and used in "any feasible way, so long as no maggots are allowed to complete their development and emerge as flies where they may have access to apple trees." We hope that "any feasible way" does not include the making of jam, though we suspect the phrase.

Poultry and Parasites. *U.S. Dept. Agr. Tech. Bull., No.* 60, 1928. There is a general impression among farmers and poultrymen that fowls may be protected from the attacks of external parasites by taking certain medicines internally. The idea underlying this treatment seems to be that the active ingredients of the medicine are absorbed by the blood and are afterwards excreted on the surface of the body, where they act by poisoning or by repelling the parasites. In America, in particular, this idea has been made use of as a commercial proposition, and many proprietary remedies have been put on the market for the destruction of fowl parasites by fowl medicines. The U.S. Department of Agriculture determined to test at one and the same time the effectiveness of the medicines and the value of the claims male by the medicine vendors. The results of the tests were observed on the fowls themselves to which the medicines were administered and on the external parasites of the fowls —lice, fleas, mites, &c. These results can be expressed in a nutshell. In no case were any deleterious effects observed on any of the external parasites feeding upon the doctored hens. In all cases the parasites fed upon these hens normally, reproduced normally, and developed normally thereafter. Where internal medicines have been used with apparent success for external parasites, it is suggested that the alleged results may have been due to imperfect observation, or to some other factor not taken into account by the investigator. Apart from the uselessness of the medicines for their specific purpose, it must always be remembered that they are harmful in two ways. They may so decrease the vitality of the fowls themselves as to lay them more open to the attacks of disease and of the very parasites they aim at destroying; and they lull their users into a false sense of security, so that they leave their poultry under the attack of the parasites, when by recognised methods of treatment the parasites might easily have been annihilated.

Roundworms in Pigs.—Much trouble is caused to growing pigs by the presence of roundworms or ascarids, which retard development and give rise to other symptoms of disturbance. The curious journey made by the parasite before it reaches its final resting place is a matter of recent discovery. In its microscopic stages the worm passes into the blood-stream and with the blood reaches the lungs, where it sets up inflammation and gives rise to "thumps" and the symptoms of pneumonia. From the lungs the young forms pass by way of the windpipe and gullet to the food-canal, and, after a journey which lasts ten days, they settle down in the intestine, where they reach maturity in the course of some 2½ months. The best method of countering the effects of this parasite lies in a healthy swine-sanitation system (*U.S. Dept. Agr.*, Leaflet No. 5, 1928), which consists essentially in obtaining fresh clean conditions for the animals, clean pasture, plenty of shade, shelter and water for old and young. As a result of the methods indicated in the leaflet, farmers can raise as many pigs from two sows as are raised from three under the usual dirty-hog conditions; the pigs are ready for market from four to eight weeks earlier, and there is the accompanying saving in feed and care; and lastly, the herds are of uniform size and quality, and practically free from runts.

MACHINES AND IMPLEMENTS.

Lecerf Mechanical Hoe for Earthing up Beets. *M. Ringelmann. Journal d'agriculture pratique, Paris* 1928, *vol.* I. *an.* 92.—This hoe invented by M. Jean Lecerf and made by the firm of Bajac, performs the processes of cultivation of beets after thinning. It is drawn by a tractor. The cultivating mechanism consists of small pointed ploughshares, followed in the same line by cultivator teeth mounted on a flexible stay. The mechanism (consisting of two parts) which works each furrow is on an independent frame, so that it has free vertical movement, but all are joined to a framework borne on two large wheels

Destruction of Botulism Toxin by Milk Bacteria. *J. M. Sherman, C. N. Stark and P. Stark. Journal of Dairy Science*, II (5), 352.—It has been shown that certain bacteria commonly found in milk have the power of destroying toxin formed by *Bacillus botulinus*—the causal agent in a certain form of "meat poisoning" This probably explains why milk and dairy products are seldom if ever agents in the dissemination of botulism. The fact that the common lactic acid germs, *Streptococcus lactis* and *B. casei*, have the power to destroy botulism toxin is of particular interest in connection with cheese, since in most types of cheese the former is the predominating organism during the early stages of ripening, while the latter is one of the predominating organisms in all types of cheese during the later stages of ripening.

A Defect in Milk due to the Action of Light. *William C. Frazier. Journal of Dairy Science*, II (5), 375.—The so called "carboard taste" and "linseed oil" odour develop in whole milk which has been exposed to diffuse daylight for eight hours or more at about freezing temperature The light apparently acts as a catalyst in the oxidation of the milk fat The defect develops more rapidly in pasteurised than in raw milk The presence of neither enzymes nor bacteria is necessary for the reaction

Fat or Butter Content as an International Standard of the Yield of Dairy Cows. *Richardson Deutsche Landwirtschaftliche Tierzucht*, Hannover, 1928, Jg 32. No 15—The author draws attention to the confusion caused by the continued use in literature of different units for measuring the lactation yield and fat yield of a cow Some figures are expressed in kilogrammes, some in litres and some in pounds, and besides, to express the yield of a cow its yield of fat is often given as well as, or instead of, its yield of butter

He notes that this makes comparison difficult between data from different cows and proposes the selection of uniform units of measure to be used internationally for the determination of lactation yield He proposes that in the German technical press results should be expressed in the unit already generally used, i e. the kilogramme, to which foreign units should be reduced when they refer to relevant data from other countries The absolute yield of the dairy cow might be expressed internationally by the fat content of milk, obtained by multiplying the milk produced by its fat content The name and measure "butter fat" or "butter content" ought to be definitely discarded

Disadvantages of Milking with the Thumb. *F Haemmerle Süddeutsche Molkereizeitung, Kempten im Allgau*, 1928, *Jg* 49, *No* 3 – By milking with the thumb a much greater mechanical stimulus is exercised on the teat than in any other method of milking Not only do the corns formed on the thumbs of most milkers who use this method cause much pain to the cows, but they also cause internal injuries to the teat Normally the mucous membrane of the teat is composed of two rows of cells Milking with the thumb or too vigorous drawing of the teat causes the formation of new layers of cells in the mucous, which may attain as much as 40 times its initial thickness and become more or less hardened The thickenings, often as large as peas, are formed mostly in the inner folds of the teat Some of these proliferations of the mucous membrane are torn during milking or become naturally detached from the parts of the tissue which often obstruct the secretory tract The author compared the teats of cows from districts where milking with the thumb is practised with those from countries where the right method, with the whole hand, is used He was able to show conclusively that with the former method thickenings in the teats are more frequent and larger than where the whole hand is used

INSECTS AND PESTS.

Apple Maggots.- The gnawing canker at the heart of the apple apparently disturbs others that the eater who comes unexpectedly upon the grub, for a considerable investigation has been devoted to it by the U S Department of Agriculture in the interests of American orchard farmers (*Tech Bull No 66*, 1928). The apple maggot is the juvenile stage of a Trypetid fly (*Rhagoletis pomonella*)—a true born native of America In its unsophisticated state it fed upon hawthorn berries and other wild fruits, but about 75 years ago the growing abundance of cultivated apples induced it to try the new fruit, which it has found to be so much to its taste that the maggot has now become one of the most serious of apple pests in the north eastern part of the United States and in south-eastern Canada As well as attacking haws and apples, it sometimes attacks pears, plums and cherries A careful account is given of the life history

of this pest, and observations have been made as to the natural enemies which might be of service in reducing its numbers. On the whole, however, it would seem that parasites and predators have very little practical effect upon the great numbers of apple flies. Experiments have shown that the best means of control is the use of a solution of commercial powdered arsenate of lead, 1 to 1½ lbs. to 50 gallons of water, used in two applications and applied as for the codling moth. Dropped infested apples should be gathered twice a week and used in "any feasible way, so long as no maggots are allowed to complete their development and emerge as flies where they may have access to apple trees." We hope that "any feasible way" does not include the making of jam, though we suspect the phrase.

Poultry and Parasites. *U.S. Dept. Agr. Tech. Bull., No.* 60, 1928. There is a general impression among farmers and poultrymen that fowls may be protected from the attacks of external parasites by taking certain medicines internally. The idea underlying this treatment seems to be that the active ingredients of the medicine are absorbed by the blood and are afterwards excreted on the surface of the body, where they act by poisoning or by repelling the parasites. In America, in particular, this idea has been made use of as a commercial proposition, and many proprietary remedies have been put on the market for the destruction of fowl parasites by fowl medicines. The U.S. Department of Agriculture determined to test at one and the same time the effectiveness of the medicines and the value of the claims male by the medicine vendors. The results of the tests were observed on the fowls themselves to which the medicines were administered and on the external parasites of the fowls —lice, fleas, mites, &c. These results can be expressed in a nutshell. In no case were any deleterious effects observed on any of the external parasites feeding upon the doctored hens. In all cases the parasites fed upon these hens normally, reproduced normally, and developed normally thereafter. Where internal medicines have been used with apparent success for external parasites, it is suggested that the alleged results may have been due to imperfect observation, or to some other factor not taken into account by the investigator. Apart from the uselessness of the medicines for their specific purpose, it must always be remembered that they are harmful in two ways. They may so decrease the vitality of the fowls themselves as to lay them more open to the attacks of disease and of the very parasites they aim at destroying; and they lull their users into a false sense of security, so that they leave their poultry under the attack of the parasites, when by recognised methods of treatment the parasites might easily have been annihilated.

Roundworms in Pigs.—Much trouble is caused to growing pigs by the presence of roundworms or ascarids, which retard development and give rise to other symptoms of disturbance. The curious journey made by the parasite before it reaches its final resting place is a matter of recent discovery. In its microscopic stages the worm passes into the blood-stream and with the blood reaches the lungs, where it sets up inflammation and gives rise to "thumps" and the symptoms of pneumonia. From the lungs the young forms pass by way of the windpipe and gullet to the food-canal, and, after a journey which lasts ten days, they settle down in the intestine, where they reach maturity in the course of some 2½ months. The best method of countering the effects of this parasite lies in a healthy swine-sanitation system (*U.S. Dept. Agr.*, Leaflet No. 5, 1928), which consists essentially in obtaining fresh clean conditions for the animals, clean pasture, plenty of shade, shelter and water for old and young. As a result of the methods indicated in the leaflet, farmers can raise as many pigs from two sows as are raised from three under the usual dirty-hog conditions; the pigs are ready for market from four to eight weeks earlier, and there is the accompanying saving in feed and care; and lastly, the herds are of uniform size and quality, and practically free from runts.

MACHINES AND IMPLEMENTS.

Lecerf Mechanical Hoe for Earthing up Beets. *M. Ringelmann. Journal d'agriculture pratique, Paris* 1928, *vol.* I, *an.* 92.—This hoe invented by M. Jean Lecerf and made by the firm of Bajac, performs the processes of cultivation of beets after thinning. It is drawn by a tractor. The cultivating mechanism consists of small pointed ploughshares, followed in the same line by cultivator teeth mounted on a flexible stay. The mechanism (consisting of two parts) which works each furrow is on an independent frame, so that it has free vertical movement, but all are joined to a framework borne on two large wheels

and yoked directly to the tractor At one time the machine works 7 furrows (" interlignes "), that is to say a breadth of 2·9 m. (beet rows spaced at 0·415 m. apart) The waste of roots caused in turning the tractor and the hoe is insignificant in comparison with the economy effected in performing the work.

Electric Vacuum Cleaner for Grooming Animals. *H. M. Kroon. Tijdschrift voor dier-geneeskunde Utrecht, Jan* 1928, *Vol* 55, *No.* 1—A specially constructed curry comb or brush can be attached to the tube of an ordinary "Electro lux" vacuum cleaner The vacuum cleaner is carried on the back or placed on a small cart and the brush and curry comb applied in the usual way The author made comparative trials, grooming animals with the electric cleaner and by hand Grooming with the vacuum cleaner has the following advantages (1) the dust does not fly in the stable, because it is sucked into the bag of the cleaner, (2) the animals are much better groomed, (3) the work is facilitated and time saved

From his experiments the author can recommend the use of a vacuum cleaner in stables supplied with electricity

A New Apparatus for Hand-Milking. *Deutsche Landwirtschaftliche Presse, Berlin,* 1928, *Jahrg* 55, *Nr* 8—This instrument, invented in Hörnig, at Grossröhrsdorf (Germany), consists of a closed can tinned on the inside, and provided towards the base with two rubber tubes whose free ends pass into a funnel fitted with a small filter During milking the instrument stands on the ground and need not be held The milk collected in this manner is nearly free from impurities and low in bacterial content An incubation experiment at 37°C showed that milk collected in an open vessel could be kept only 36 hours, whereas that received in the new instrument could be kept 96 hours

The North of Scotland College of Agriculture,

MARISCHAL COLLEGE,

ABERDEEN.

Winter Session - October to March.
Summer Session - April to June.

Qualifying Courses for B.Sc. (Agr.), (Ordinary and Honours Degrees), College Diploma in Agriculture, National Diploma in Agriculture, Special Farmers' Course, Planters' Certificate Course, Residential Course in Rural Domestic Economy for Girls at Craibstone, &c.

CALENDAR giving full particulars of Courses of Instruction, Syllabus of Experimental Work, Particulars of Advisory Work undertaken by the College, &c.; and Prospectus of Craibstone School of Rural Domestic Economy, may be had on application to—

A. A. PROSSER, *Secretary*,
Crown Mansions,
41½ Union Street, ABERDEEN.

The West of Scotland Agricultural College,

GLASGOW AND KILMARNOCK.

THE CLASSES in Glasgow qualify for the B.Sc. (Agric.), Ordinary and Honours Degrees; for the College Diploma in Agriculture, in Dairying, in Poultry Keeping, and in Horticulture.

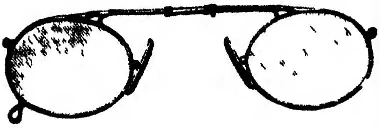
Session—October till March.

The Dairy School at Kilmarnock is open during January and February for Short Courses, and from April till October for Practical Instruction in Butter and Cheese Making. Pupils are prepared for the N.D.D. Fxamination.

The Poultry Department is open all the year round.

JOHN CUTHBERTSON,
Secretary.

6 BLYTHSWOOD SQUARE, GLASGOW.



GEO. PRESCOTT & CO.

CONSULTING OPTICIANS.

Principal:	**Telephone:**
J. H. MURRAY.	21478.

—:o —

All our lens grinding and assembling is done in Edinburgh under the direct supervision of our refractionists—and particular attention is given to the aesthetic value of the glasses prescribed.

—:o.—

98 LOTHIAN ROAD,

EDINBURGH

TOOGOOD'S SEEDS

have an unrivalled reputation for quality extending well over 100 years, and have won numerous Gold Medals and other prizes. They are

THE BEST THAT GROW

The 1928 Editions of our profusely Illustrated

CATALOGUES

of the most productive strains of

GRASSES, CLOVERS & ROOT SEEDS.

The best

VEGETABLES AND FLOWER SEEDS.

Write for the copy you require.
It is free by post.

TOOGOOD & SONS, LTD.

SOUTHAMPTON.

Seedsmen to H.M. the King, and growers of "Better Crop" Seed only.

Established 113 Years.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in September, October and November 1928.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	September.			October.			November.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK :—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ...	65 10	58 3	43 3	64 4	56 11	42 4	64 9	57 4	41 8
Cross-bred (Shorthorn)	59 0	51 10	38 0	57 3	49 6	35 9	57 10	50 2	35 10
Galloway	55 6	51 0	...	52 8	48 10	..	54 5	50 6	...
Ayrshire	55 3	44 6	33 3	52 10	41 5	31 5	53 3	42 3	31 6
Blue Grey	...	...	...	55 6	...	...	...	...	...
Highland	...	...	...	...	...	...	...	...	...
	per lb. d.	per lb. d.	per lb d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	14	8¼	4¼	14	7¾	4	14¾	8½	4½
†SHEEP—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d	Ewes per lb d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	14	13¼	10	13¾	12½	9½	13¾	13	9¾
Half-bred	13½	12½	8½	12¾	11¾	8½	13½	12¼	8½
Blackface	12¾	11¾	9½	12¼	11¼	9¼	13	12¼	9
Greyface	13¼	12¼	9¼	13	12¼	8¾	13¼	12½	9
Down Cross	13¼	12¼	8	13	11¾	7¾	13¼	12¼	8¼
†PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d	per stone. s. d.
Bacon Pigs	11 9	10 5	...	11 6	10 4	...	11 4	10 1	..
Porkers	12 1	10 10	...	11 10	10 7	...	11 8	10 5	...

* Live weight.   † Estimated dressed carcase weight.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets—*continued.*

Description.	September.			October.			November.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK :—									
CATTLE—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.
Aberdeen-Angus :	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	18 3	14 2	13 6	18 10	14 11	12 1	17 7	14 5	11 17
Two-year-olds ...	24 17	20 3	16 8	23 18	19 13	16 12	23 6	19 0	13 10
Cross-bred (Shorthorn):									
Yearlings	16 19	12 14	12 2	16 6	12 15	10 15	15 8	12 2	10 16
Two-year-olds ...	24 0	18 10	15 10	22 11	18 4	15 16	22 4	17 13	13 1
Galloway :									
Yearlings	14 7	...	...	14 4	...	...	13 10	...	...
Two-year-olds ...	21 15	19 0	...	23 10	19 0	...	19 8	18 10	...
Ayrshire :									
Yearlings	13 0	...	...	10 0	...	...	9 10	...	...
Two-year-olds ...	...	...	...	12 5	...	...	14 10	...	...
Highland :									
Yearlings	11 18	9 8	7 3	11 1	9 1	6 12	9 12	8 0	6 12
Two-year-olds ...	14 17	12 10	9 10	14 10	12 1	9 17	15 2	12 2	9 18
Three-year-olds ...	18 0	15 0	12 0	19 7	15 19	13 1	17 10	15 5	13 5
DAIRY COWS—									
Ayrshire :									
In Milk	29 12	22 3	12 0	29 16	21 13	12 12	31 5	22 6	12 0
Calvers	29 19	22 9	15 0	30 10	21 18	15 8	30 7	22 1	15 3
Shorthorn Cross :									
In Milk	32 17	23 6	18 0	33 3	23 3	19 5	33 12	24 1	16 12
Calvers	32 2	22 15	18 3	31 14	22 5	16 17	31 6	22 4	17 2
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	...	...	...	46 0	42 8	...	...	...	...
Half-bred Hoggs ...	...	...	...	66 2	50 9	...	...	...	...
Blackface Hoggs ...	...	...	...	48 5	37 3	...	...	...	...
Greyface Hoggs ...	...	...	...	...	39 9	...	...	...	...
Down Cross Hoggs	...	...	...	...	...	...	...	...	...
PIGS—									
(6 to 10 weeks old)	24 5	16 11	...	24 0	17 0	...	24 10	16 6	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	Quality.	September. Dundee.	September. Edinburgh.	September. Glasgow.	October. Dundee.	October. Edinburgh.	October. Glasgow.	November. Dundee.	November. Edinburgh.	November. Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF:—										
Home-fed—										
Bullock or Heifer ...	1	9⅛	8⅞	12	8¾	8	11	8¾	7⅝	11⅛
	2	8⅝	...	9⅛	8	...	9¼	8	7½	9⅝
Bull	1	7¼	7⅝	7⅝	7	6½	6¾	7	6⅜	6⅝
	2	6¼	6⅛	6⅞	6	6	6¼	6	...	6⅛
Cow	1	6½	5⅞	7⅛	6½	5¼	6⅜	6⅛	5½	6⅝
	2	5⅛	5¼	6⅝	5⅛	...	5¾	5⅛	...	5¾
Irish—										
Bullock or Heifer ...	1	...	...	7¾	...	...	6⅞	...	...	6¾
	2	...	...	7⅛	...	...	6⅛	...	...	6⅛
Argentine Frozen—										
Hind Quarters ...	1	6	7⅛	7	5¾	7	5⅝	.5⅞	7	5½
	2	..	6	6⅛	5⅛	5⅝	5¼	5	5⅛	5¼
Fore ,, ...	1	4½	4⅝	4¼	4⅛	4⅝	4⅛	4⅛	4⅞	4
	2	...	4¼	4	4¼	4¼	4	4¼	4⅛	...
Argentine Chilled—										
Hind Quarters ...	1	8⅛	8	7⅞	6⅞	6⅝	6⅝	7	6⅞	7
	2	6⅞	7⅛	7⅝	6⅛	6¼	6⅛	...	6¾	6⅝
Fore ,, ...	1	5⅛	4⅞	5	4⅞	4¾	4¾	5⅛	4⅞	5⅛
	2	4⅝	4⅛	4⅛	...	4⅝	4¼	...	...	4⅝
Australian Frozen—										
Hind Quarters ...	1	...	...	7	...	...	5¼	...	...	5
	2	...	...	6½	...	...	4⅞	...	...	4⅛
Crops	1	...	...	4	...	...	4	...	...	4
New Zealand Frozen—										
Hind Quarters ...	1	...	...	7	...	...	5¼	...	...	5
	2	..	...	6⅛	...	...	4¾	...	...	4⅛
Fore ,, ...	1	..	...	4	...	...	4	...	...	4
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	11½	11	11	12	9⅞	10⅛	12	9½	10¾
	60 lb. & over	11	...	10⅝	11	...	9¾	11	...	10¼
,, Cross	under 60 lb.	11½	11	11	12	9⅞	10⅛	12	9½	10¾
	60 lb. & over	11	...	10⅝	11	...	9¾	11	...	10¼
Ewes, Cheviot	1	...	7⅛	7⅝	...	6½	7⅛	...	6½	7⅝
	2	...	...	7⅛	...	...	6⅝	...	...	6⅞
,, Blackface ...	1	7¾	7⅛	7⅝	8	6⅛	6¾	8	6⅛	7⅛
	2	7	...	6⅞	7	...	6⅝	7	...	6⅛
,, Cross	1	6	7⅛	6⅝	6	6⅛	5¾	6	6⅛	6⅛
	2	5	...	5⅞	5	...	5¼	5	...	5⅝
Argentine Frozen ...	1	...	...	6⅛	..	...	5¾	...	...	5⅛
	2	...	...	5⅛	...	...	5⅛	...	...	5
Australian ,, ...	1	...	6⅛	6	...	6¼	5⅝	...	5⅛	5½
	2	...	5⅞	5⅛	...	5¾	5⅛	...	5	5
New Zealand ,, ...	1	...	..	7	...	...	6¼	...	...	6
	2	...	...	6	...	...	5⅝	...	...	5⅛
LAMB:—										
Home-fed	1	12	12¾	12	12	10⅞	11⅛	...	10⅞	11¾
	2	...	...	11⅝	...	...	10⅛	...	...	11¼
New Zealand Frozen ...	1	...	11	10⅝	...	10¼	10⅛	...	10	10⅛
	2	...	10½	10	...	...	10	...	...	10
Australian ,, ...	1	...	...	8¾	...	...	8¾	...	...	8¾
	2	...	...	8⅛	...	...	8⅛	...	...	8⅛
Argentine ,, ...	1	...	...	8	...	...	8	...	...	8
	2	...	...	7¾	...	...	7¾	...	..	7¾

Provisions: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Department's Market Reporter.)

Description.		Quality.	September. s. d.	October. s. d.	November. s. d.
Butter:					
Irish Creamery	per cwt.	1	184 9	188 0	188 6
,, (Unsalted) ...	,,	1	188 3	187 0	187 3
Danish	,,	1	199 0	198 2	202 3
,, (Unsalted) ...	,,	1	202 6	201 2	206 3
New Zealand	,,	1	192 9	189 2	188 3
,, (Unsalted) ...	,,	1	196 0	192 7	...
Australian	,,	1	175 6	176 2	176 3
Siberian	,,	1	168 6	169 0	170 6
Swedish	,,	1	189 9	190 10	198 0
Cheese:					
Cheddar	,,	1	124 9	121 5	125 0
		2	115 0	112 0	116 0
Cheddar (Loaf)	,,	1	135 0	140 0	139 0
		2	...	136 0	135 0
Dunlop	,,	1	120 0	117 7	117 6
		2	112 0	110 6	112 0
Canadian...	,,	1	117 9	116 10	116 0
New Zealand (Coloured)	,,	1	120 3	118 5	115 0
,, (White)	,,	1	121 0	119 7	116 0
Bacon:					
Ayrshire (Rolled) ...	,,	1	132 0	129 2	124 0
Irish (Green)	,,	1	125 3	112 10	112 0
,, (Dried or Smoked)	,,	1	132 9	119 0	119 0
,, (Long Clear) ...	,,	1	126 6	118 0	113 0
Wiltshire (Green) ...	,,	1	122 0	113 0	112 0
,, (Dried or Smoked)	,,	1	129 0	118 10	119 0
American, Short Clear Backs	,,	1	106 6	108 0	..

Description.		Quality.	September. s. d.	October. s. d.	November. s. d.
Bacon—*continued.*					
Danish Sides	per cwt.	1	113 0	99 5	100 6
Dutch, Wiltshire Style (Green)	,,	1	104 9	95 2	95 3
Hams:					
Irish (Smoked)	,,	1	197 0	189 0	169 6
		2	182 0	174 0	158 3
American, Long Cut (Green)	,,	1	123 3	122 5	119 0
American, Short Cut ...	,,	1	111 0	112 10	110 6
Eggs:					
Country	per doz.	1	2 2	2 9	3 2
		2	2 1	2 7	3 1
Irish	per 120.	1	17 4	21 10	26 5
		2	16 4	18 8	...
,, (Cold Stored) ...	,,	1	14 9	14 2	13 10
,, (Duck)	,,	1	14 6	15 6	...
Belgian	,,	1	15 10	19 5	23 11
		2	15 4	18 4	23 0
Danish	,,	1	16 6	20 4	25 8
		2	15 7	18 7	23 11
Dutch	,,	1	14 6	17 1	22 9
,, (Duck)	,,	1	13 8	18 4	13 6
Swedish	,,	1	16 8	20 1	25 8
		2	15 9	18 2	23 11
Polish (Blue)	,,	1	10 11	11 8	12 8
,, (Red)	,,	1	9 9	10 9	11 2
Russian	,,	1	11 2	14 8	14 11
		2	10 8	11 6	11 9

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Department's Market Reporter.)

Description.		Quality.	September.	October.	November.
FRUIT:—			s. d.	s. d.	s. d.
Apples—					
American ...	... per case.*	1	13 9	11 10	...
,, ...	... per barrel.**	1	...	...	24 0
Canadian ...	... per case.*	1	...	...	10 4
Damsons	... per lb.	1	0 5	...	...
Plums, Victoria ...	... ,,	1	0 5¾	0 6	...
VEGETABLES:—					
Beet	... per cwt.	1	7 9	7 5	7 0
Brussels Sprouts	.. ,,	1	...	23 2	20 0
Cabbage, Coleworts	... per doz.	1	2 6	1 11	...
,, Savoy ...	... ,,	1	...	2 2	2 11
Carrots, *British* ...	.. per cwt.	1	8 0	6 6	6 2
Cauliflowers, *British*	... per doz.	1	3 6	4 2	5 9
Celery	... per bunch.	1	2 8	2 6	2 6
Cucumbers ...	... per doz.	1	6 0	6 0	...
Leeks	per doz. bunches.	1	4 6	3 0	3 0
Lettuce, Cabbage	... per doz.	1	1 10½	1 6	...
Onions, *Dutch* ...	... per bag.‡	1	...	10 0	16 0
,, *Valencia*	... per case.†	1	11 9	12 2	12 6
Parsley	... per cwt.	1	12 0	10 10	12 0
Parsnips	... ,,	1	13 0	10 0	9 6
Peas	.. ,,	1	21 4	20 0	...
Rhubarb	... ,,	1	6 0	...	...
Tomatoes, *British*	... per lb.	1	0 6	0 6½	0 7½
,, *Channel Islands*	,,	1	0 4	0 5½	...
,, *Canary*	... ,,	1	...	...	0 6
Turnips	... per cwt.	1	3 9	2 8	2 6
Vegetable Marrow	... per doz.	1	5 6	4 6	...

* 40 lbs. (approx.). ** 120 lbs. (approx.). † 9 stones (approx.). ‡ 7½ stones (approx.)

Potatoes: Monthly Average Wholesale Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Department's Market Reporters.)

Market.		Quality.	Second Earlies.	Late Varieties. Red Soils. Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Golden Wonder.	Late Varieties. Other Soils. Other.
September.							
			£ s.	£ s.	£ s.	£ s.	£ s.
Dundee ...	per ton.	1	5 5	...	...	...	...
Edinburgh ...	,,	1	4 13	...	...	...	...
Glasgow ...	,,	1	7 3	...	...	...	...
October.							
Dundee ...	per ton.	1	3 15	...	...	...	3 19
Edinburgh ...	,,	1	4 15	...	...	...	5 0
Glasgow ...	,,	1	7 0	...	...	..	6 0
November.							
Dundee ...	per ton.	1	...	...	...	...	3 8
Edinburgh ...	,,	1	...	...	...	..	4 6
Glasgow ...	,,	1	...	...	6 0	...	4 18

Roots, Hay, Straw, and Moss Litter: Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Department's Market Reporters.)

Market.		Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
September.											
			s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
‖ Dundee ...	per ton.	1	...	...	...	115 0† 105 0‡	...	60 0	...	60 0	52 6*
Edinburgh	,,	1	...	...	...	90 0‡	...	52 6‡	...	47 6‡	...
‖ Glasgow	,,	1	...	...	...	81 3†	88 9†	40 0	40 0	42 6	32 2**
October.											
‖ Dundee ...	,,	1	...	17 9	...	118 0† 108 0‡	...	60 0	...	60 0	50 6*
Edinburgh	,,	1	...	...	...	100 0† 95 0‡	...	55 0‡	42 6†	50 0‡	...
‖ Glasgow	,,	1	...	...	...	80 0†	90 0†	40 0	40 0	42 6	32 6**
November.											
‖ Dundee ...	,,	1	...	17 6	20 0	116 3† 106 3‡	...	57 6	60 0	60 0	50 0*
Edinburgh	,,	1	...	...	...	100 0† 95 0‡	...	55 0‡	42 6†	50 0‡	...
‖ Glasgow	,,	1	...	...	...	81 11†	84 5†	43 9	41 11	44 5	32 6**

‖ Baled Straw delivered. * Foreign (ex quay). † Delivered baled.
** Home (in 1½ cwt. bales). ‡ Delivered loose.

Feeding Stuffs: Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	September.		October.		November.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	12 17 6	12 10 0	12 10 0	12 15 0	12 10 0	12 15 0
Foreign	12 8 2	...	12 4 0	...	12 16 3	...
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)...	8 2 6	7 11 3	7 16 0	7 11 6	8 5 0	8 0 0
Egyptian (do.)	8 16 3	...	8 10 6	8 2 6	8 10 0	8 5 0
Palmnut Kernel Cake	11 0 0	...	11 2 0	...	11 3 2	...
Soya Bean Cake ...	13 5 0	12 0 0	13 5 0	12 0 0	13 5 0	12 0 0
Coconut Cake ...	12 2 6	..	12 3 0	...	12 10 0	...
Groundnut Cake, Undecorticated—						
37 per cent. Oil and Albuminoids	9 19 5	..	9 15 6	...	10 0 0	...
40 per cent. do.	10 3 9	...	9 19 0	...	10 4 5	...
Maize Germ Cake—						
Home	11 10 0	...	11 13 0	...	11 15 0	...
Barley Meal ...	11 14 5	10 7 6	10 19 6	11 0 0	10 10 0	11 0 0
Bean Meal	13 5 0	...	12 11 6	...	12 14 5	...
Maize Meal—						
Home Manufactured	11 3 9	10 10 0	10 19 6	10 19 0	11 11 11	11 0 0
South African—						
(Yellow) ...	10 11 3	...	10 12 6	..	11 1 3	...
(White) ...	11 0 0	...	10 2 6	...	10 5 8	...
Rice Meal	8 18 9	..	8 15 0	...	8 15 0	...
Locust Bean Meal .	10 2 6	9 12 6	10 2 6	9 10 0	10 4 5	9 10 0
Fish Meal	19 6 3	20 0 0	19 10 0	20 0 0	19 15 0	20 0 0
Maize Gluten Feed (Paisley) ...	10 0 0	..	10 1 0	...	10 8 9	...
Maize—Plate ...	9 16 3	9 10 0	10 2 6	9 19 0	10 9 5	10 5 0
Do. American ..	9 18 9	..	10 9 6	..	10 11 11	...
Do. African Flat	9 15 0	...	10 3 9	..	10 10 0	...
Oats—Home ...	11 15 0	11 10 0	11 2 0	11 2 0	9 12 6	8 10 0
Do. Plate ...	9 3 2	...	9 2 0	...	9 5 0	...
Do. Canadian No. 3	10 15 8	...	10 13 0	...	...	...
Barley Feeding (Home)	10 10 0	...	11 2 6	...	10 6 3	...
Do. Bran ...	10 10 0	...	10 10 0	...	10 5 0	...
Wheat—						
Home	10 11 3	9 7 6	10 13 6	9 5 0	10 15 0	9 5 0
Imported... ...	9 15 0	..	9 15 0	...	9 5 10	9 5 0
Middlings (Fine Thirds or Parings)	10 14 5	10 0 0	10 9 6	10 0 0	10 3 9	10 0 0
Sharps (Common Thirds) ...	8 11 3	8 12 6	8 6 6	8 10 0	8 6 11	8 10 0
Bran (Medium) ...	8 1 11	8 1 11	8 2 0	8 0 0	8 7 6	8 0 0
,, (Broad) ...	8 6 11	9 0 0	8 6 0	...	8 11 3	...
Malt Culms... ...	8 7 6	...	8 8 0	...	8 10 0	...
Distillery Mixed Grains—Dried	9 7 6	9 7 6	...	9 5 0	...	9 5 0
Brewers' Grains—						
Dried	9 10 0	8 7 6	10 4 2	8 5 0	10 5 0	8 5 0
Distillery Malt Grains—Dried	9 16 11	...	9 10 6	...	9 14 5	...
Crushed Linseed ...	20 10 0	...	20 19 0	..	20 15 0	...
Locust Beans, Kibbled & Stoned	9 7 6	8 15 0	9 7 6	8 15 0	9 9 5	8 15 0
Beans—English ...	12 12 6	...	12 7 0	...	12 12 6	...
Do. China ...	11 16 3	11 15 0	11 8 6	11 10 0	11 10 0	11 10 0
Do. Rangoon (White)	10 13 9	...	10 13 0	...,	10 17 6	...
Pease, Calcutta (White)	13 10 0	...	13 10 0	...	13 10 0	...
Feeding Treacle ...	7 1 3	7 0 0	7 2 6	7 0 0	7 4 5	7 0 0

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	September. Glasgow.	September. Leith.	October. Glasgow.	October. Leith.	November. Glasgow.	November. Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda § ...	N. 15½	...	...	10 2 0	10 2 0	10 4 0	...
Calcium Cyanamide ‖	N. 20·6	9 2 0	...	9 4 0	...	...	...
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	10 0 0	10 0 0	10 1 7	10 2 7	10 5 0	10 5 0
Superphosphate ...	P.A. 13·7	2 7 6	...	2 7 6	...	2 7 6	...
"	" 16·0	2 12 6	...	2 12 6	...	2 12 6	..
"	" 17·4	...	...	...	...	2 17 6	...
Ground Mineral Phosphate † ...	P.A. 25·66	...	...	2 3 6	...	2 5 0	...
Potassic Mineral Phosphate	P.A. 18 Pot. 10	...	3 15 0	...	3 15 0	...	3 15 0
" "	P.A. 18 Pot. 5	...	3 5 0	...	3 5 0	..	3 5 0
Kainit (in bags) ...	Pot. 14	3 1 0	3 2 6	3 1 0	3 2 6	..	3 2 6
Potash Salts ...	Pot. 20	3 10 0	3 11 3	3 10 0	3 11 3	...	3 11 3
" " ...	Pot. 30	4 17 6	4 18 9	4 17 6	4 18 9	...	4 18 9
Muriate of Potash... (on basis of 80 per cent. purity)	Pot. 50	9 0 0	8 17 6	9 0 0	8 17 6	..	8 17 6
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 2 6	10 17 6	11 2 6	10 17 6	...	10 17 6
Steamed Bone Flour	N. 1 P.A. 27·5	6 10 0	...	6 10 0	...	6 10 0	...
Bone Meal—Home	N. 4 P.A. 22·9	9 0 0	...	9 0 0	...	9 0 0	...
" " Indian	N. 5 P.A. 22·9	9 10 0	...	9 10 0	...	9 10 0	...
Basic Slag	P.A. 11	*2 1 9	...	*2 1 9	...	*2 1 9	...
" "	" 12	*2 2 9	**2 1 6	*2 2 9	**2 1 6	*2 2 9	**2 1 6
" "	" 13	*2 3 9	**2 2 8	*2 3 9	**2 3 6	*2 3 9	**2 3 6
" "	" 14	*2 5 9	**2 5 6	*2 5 9	**2 5 6	*2 5 9	**2 5 6
" "	" 15	*2 7 9	...	*2 7 9	...	*2 7 9	...
" "	" 18	...	‡3 0 0	...	‡3 0 0	...	‡3 0 0
Nitrate of Lime ...	N. 13	11 5 0	...	11 5 0	..	...	...

Abbreviations :—N. = nitrogen ; Pot. = Potash ; P.A. = Phosphoric Acid.

§ Carriage paid in 6-ton lots. ‖ Carriage paid in 4-ton lots.
† Fine grist 80 per cent. fineness through standard 100 mesh sieve.
‡ Foreign slag at Leith.
* Carriage paid in 6-ton lots to Lanarkshire and Renfrewshire stations.
** " " Lothians stations.

STATEMENT SHOWING THE ACREAGE UNDER EACH VARIETY OF POTATOES IN SCOTLAND IN 1928.

Variety.	Acres.
A. FIRST EARLIES.	
1. Arran Rose *	35
2. Dargill Early *	51
3. Di Vernon *	27
4. Herald *†	38
5. Immune Ashleaf * ...	50
6 Snowdrop (including Witch Hill) *	78
7. Beauty of Hebron (including Puritan) ...	99
8. Duke of York (including Midlothian Early and Victory)	1,850
9. Eclipse (including Sir John Llewelyn) ...	2,878
10. Epicure	8,128
11. May Queen	234
12. Ninetyfold	153
13. Sharpe's Express ...	1,341
14. Sharpe's Victor	39
15. Other First Earlies not specified above ...	58
Total First Earlies ...	15,059
B. SECOND EARLIES.	
16. Ally *	1,542
17. Arran Comrade * ...	398
18. Catriona *	102
19. Edzell Blue *	340
20. Great Scot *	12,287
21. Katie Glover *	54
22. King George V. * ...	529
23. British Queen (including Pioneer, Macpherson, Maid of Auchterarder, Scottish Standard, English Beauty, &c) ...	3,568
24. Royal Kidney (including Queen Mary)	445
25. Other Second Earlies not specified above ...	148
Total Second Earlies	19,413
C. MAINCROPS.	
26. Sutton's Abundance (including Admiral, Balmuir, Bloomfield, Culdees Castle, Kerr's New White, Laing's Prolific, Lomond, Twentieth Century, Osborne Seedling, Just in Time, &c.)*	883
27. Arran Banner *† ...	81
28. Arran Consul *†... ...	2,430
29. Arran Victory *	603
30. Bishop *	143
31. Champion *	757
32. Crusader *	171
33. Early Market *	53
34. Golden Wonder (including Peacemaker) * ...	7,429
35. Irish Queen *	420
36 Kerr's Pink *	44,539
37. Langworthy (including Maincrop and What's Wanted) *	342
38. Lochar *	76
39. Majestic *	8,024
40. Rhoderick Dhu * ...	695
41. Tinwald Perfection * ...	463
42. Arran Chief	8,343
43. Evergood	128
44. Field-Marshal	912
45. General	85
46. King Edward VII. (including Red King) ...	13,310
47. Northern Star (including Ajax, Allies and Aeroplanes)	125
48. President (including Iron Duke and Scottish Farmer)	233
49. Up-to-Date (including Dalhousie, Factor, Glamis Beauty, Scottish Triumph, Stephen, Table Talk, Laing's Imperial, &c.)	1,544
50. Other Maincrops not specified above ...	634
Total Maincrops ...	92,423
TOTAL AREA CLASSIFIED, ...	126,895
ACREAGE NOT INCLUDED, ...	17,131
TOTAL ACREAGE GROWN, ...	144,026

NOTES.—(1) The following districts are excluded:—In the county of Inverness—Skye, Harris, North and South Uist; in the county of Ross and Cromarty—Western, South-Western, Lewis.
(2) Returns showing a total area of less than one acre under potatoes are not tabulated.
(3) Varieties marked thus * are immune from Wart Disease
(4) Varieties marked thus † have been registered by the Board of Agriculture for Scotland as new varieties.

ABSTRACT OF AGRICULTURAL RETURNS FOR SCOTLAND, 1928.

Collected 4th June 1928 (and comparison with 1927).

CROPS.

Distribution.	1928.	1927.	Increase.		Decrease.	
	Acres	*Acres.*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
Total Area (excluding Water)	19,069,408	19,069,408	..	..	..	..
Mountain and Heath Land used for Grazing (*b*)	9,707,768	9,896,854	..	..	189,086	1·9
Total Acreage under Crops and Grass ..	4,665,462	4,681,221	..	..	15,759	0·3
Arable Land	3,133,430	3,168,624	..	..	35,194	1·1
Permanent Grass — For Hay ..	166,300	167,212	..	..	912	0·5
Permanent Grass — Not for Hay ..	1,365,732	1,345,385	20,347	1·5	..	..
Permanent Grass — Total ..	1 532,032	1,512,597	19,435	1·3	..	..
Wheat	58,227	66,577	..	..	8,350	12·5
Barley (including Bere)	111,924	117,369	..	..	5,445	4·6
Oats	878,436	897,370	..	..	18,934	2·1
Mixed Grain	1,338	1,240	98	7·9	..	..
Rye..	3,131	3,868	..	..	737	19·1
Beans (to be harvested as Corn)	3,151	3,574	.	..	423	11·8
Peas	346	422	..	..	76	18·0
Potatoes	144,026	147,184	..	..	3,158	2·1
Turnips and Swedes	378,003	376,693	1,310	0·3	..	..
Mangolds	1,250	1,124	126	11·2	..	..
Sugar Beet	2,313	10,352	..	..	8,039	77·7
Cabbage	4,319	4,197	122	2·9	..	..
Rape	11,690	12,916	..	..	1,226	9·5
Vetches or Tares, for Seed	142	220	.	..	78	35·5
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	11,879	11,589	290	2·5	..	..
Carrots	370	326	44	13·5	..	..
Onions	133	137	..	..	4	2·9
Flax	3	206	..	.	203	98·5
Small Fruit	3,006	3,064		..	58	0·7
Rye-grass and other Rotation Grasses and Clover — For Hay	400,753	399,672	1,081	0·3	..	..
Rye-grass and other Rotation Grasses and Clover — Not for Hay ..	1,105,516	1,096,691	8,825	0·8	..	..
Rye-grass and other Rotation Grasses and Clover — Total	1,506,269	1,496,363	9,906	0·7	..	..
Other Crops	2,675	2,683	..	.	8	0·3
Bare Fallow	5,799	6,150		.	351	5·7
Orchards (*a*)	1,103	1,288	.	..	185	14·4

LIVE STOCK.

	1928.	1927.	Increase.		Decrease.	
	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding)	125,864	129,526	..	..	3,662	2·8
Unbroken Horses (including Stallions). — One year and above ..	16,491	17,244	..	..	753	4·4
Unbroken Horses (including Stallions). — Under one year ..	5,093	5,671	..	..	578	10·2
Total	147,448	152,441	..	..	4,993	3·3
Other Horses	18,290	19,661	..	..	1,371	7·0
Total of Horses	165,738	172,102	..	..	6,364	3·7
Cows in Milk	356,121	355,460	661	0·2	..	..
Cows in Calf, but not in Milk..	50,812	49,273	1,539	3·1	..	..
Heifers in Calf	52,284	55,584	..	..	3,300	5·9
Bulls being used for Service	17,031	17,578	..	..	547	3·1
Other Cattle :—Two years and above ..	194,076	208,416	..	..	14,340	6·9
„ „ One year and under two ..	290,483	276,817	13,666	4·9	..	..
„ „ Under one year	253,041	247,322	5,719	2·3	..	..
Total of Cattle	1,213,848	1,210,450	3,398	0·3	..	..
Ewes kept for Breeding	3,275,165	3,239,143	36,022	1·1	..	..
Rams to be used for Service in 1928	90,517	90,701	..	..	184	0·2
Other Sheep :—One year and above . ..	995,747	995,005	742	0·1	..	..
„ „ Under one year	3,217,275	3,210,628	6,647	0·2	..	..
Total of Sheep	7,578,704	7,535,477	43,227	0·6	..	..
Sows kept for Breeding	22,210	26,662	..	..	4,452	16·7
Boars being used for Service	2,457	2,711	..	..	254	9·4
Other Pigs	170,837	167,240	3,597	2·2	..	..
Total of Pigs	195,504	196,613	..	..	1,109	0·6

(*a*) Any Crop or Grass grown in Orchards is also returned under its proper heading.
(*b*) Includes land on Deer Forests used for grazings.

ACREAGE under WHEAT, BARLEY (including BERE) and OATS in each COUNTY on 4th June 1928, with COMPARISON for 1927.

COUNTIES.	Wheat.		Barley (including Bere).		Oats.	
	1928.	1927.	1928.	1927.	1928.	1927.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	12	42	11,394	14,138	177,869	181,179
ANGUS	12,027	12,879	12,048	12,164	55,280	55,614
ARGYLL	2	...	814	815	14,924	15,258
AYR	1,324	1,438	77	109	34,533	35,585
BANFF	14	...	6,645	6,806	44,181	45,577
BERWICK	1,671	2,691	11,776	12,496	25,320	26,245
BUTE	9	2	7	12	4,336	4,456
CAITHNESS ...	...	...	533	568	27,018	28,346
CLACKMANNAN ...	236	286	94	103	2,843	2,768
DUMBARTON ...	363	487	5	7	6,153	6,409
DUMFRIES ...	50	45	63	63	33,834	35,370
EAST LOTHIAN ...	5,170	7,201	12,931	12,400	14,608	14,217
FIFE	12,310	13,651	11,094	10,736	40,461	40,423
INVERNESS ...	27	39	3,723	4,000	28,218	28,630
KINCARDINE ...	949	1,213	6,121	6,987	30,880	30,388
KINROSS	267	310	99	101	6,179	6,539
KIRKCUDBRIGHT...	53	50	53	28	19,691	20,312
LANARK	1,945	2,072	74	86	34,344	35,232
MIDLOTHIAN ...	5,227	6,088	3,453	3,155	19,119	19,102
MORAY	915	794	8,117	8,482	23,590	24,164
NAIRN	...	...	1,937	1,993	6,278	6,444
ORKNEY	...	...	3,364	3,475	30,931	31,812
PEEBLES	...	...	59	26	5,239	5,685
PERTH	7,787	8,533	2,442	2,217	62,939	64,581
RENFREW ...	1,722	1,732	4	1	8,697	8,852
ROSS & CROMARTY	1,030	1,065	5,721	6,516	31,561	31,927
ROXBURGH ...	1,120	1,259	6,690	7,189	21,886	22,865
SELKIRK	5	...	141	144	3,306	3,499
SHETLAND ...	...	...	553	606	6,037	6,063
STIRLING	1,483	1,841	393	452	16,472	16,876
SUTHERLAND ...	...	...	215	226	7,014	7,111
WEST LOTHIAN ...	2,485	2,819	1,194	1,172	10,200	9,749
WIGTOWN	24	40	90	96	24,495	26,092
TOTAL ...	58,227	66,577	111,924	117,369	878,436	897,370

ACREAGE under POTATOES, TURNIPS and SWEDES and SUGAR BEET in each COUNTY on 4th June 1928, with COMPARISON for 1927.

Counties.	Potatoes.		Turnips and Swedes.		Sugar Beet.	
	1928.	1927.	1928.	1927.	1928.	1927.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	7,827	7,847	78,591	79,057	42	366
ANGUS	18,650	19,880	29,550	28,281	112	777
ARGYLL	2,714	2,726	4,750	4,814	...	180
AYR	8,628	8,578	6,608	6,953	...	760
BANFF	1,892	1,839	19,087	19,160	12	77
BERWICK	2,464	2,532	18,710	18,579	125	504
BUTE	1,012	984	1,161	1,204	...	...
CAITHNESS ...	1,091	1,142	10,427	10,470	...	1
CLACKMANNAN ...	376	396	706	725	...	37
DUMBARTON ...	2,260	2,323	1,358	1,307	...	2
DUMFRIES ...	3,319	3,230	13,960	14,360	...	7
EAST LOTHIAN ...	8,017	8,013	11,634	11,643	445	1,130
FIFE	16,525	16,922	20,387	18,919	1,230	3,819
INVERNESS ...	5,019	5,121	8,594	8,844	...	...
KINCARDINE ...	4,246	4,656	14,950	14,508	34	258
KINROSS	1,161	1,248	2,246	2,176	...	68
KIRKCUDBRIGHT	1,356	1,341	8,560	9,053	1	15
LANARK	6,175	6,008	8,999	9,061	1	20
MIDLOTHIAN ...	6,285	6,748	9,040	8,598	48	383
MORAY	1,708	1,564	13,164	13,037	68	267
NAIRN	275	275	3,740	3,730	10	27
ORKNEY	2,253	2,230	12,844	13,030	...	...
PEEBLES	331	318	2,631	2,726	...	...
PERTH	18,277	18,889	22,866	22,235	132	674
RENFREW	3,372	3,313	1,853	1,898	...	5
ROSS & CROMARTY	6,916	6,975	13,410	13,439	...	167
ROXBURGH ...	1,220	1,150	15,445	15,619	27	253
SELKIRK	131	162	1,883	1,934	...	3
SHETLAND ...	1,994	1,996	980	1,006	...	...
STIRLING	3,363	3,378	3,488	3,473	...	107
SUTHERLAND ...	1,047	1,058	2,518	2,582	...	...
WEST LOTHIAN ...	2,537	2,778	3,061	2,880	11	147
WIGTOWN	1,585	1,564	10,802	11,392	15	298
TOTAL	144,026	147,184	378,003	376,693	2,313	10,352

ACREAGE under RYE-GRASS and other ROTATION GRASSES and CLOVER, and under PERMANENT GRASS in each COUNTY on 4th June 1928, with COMPARISON for 1927.

COUNTIES.	Rye-grass and other Rotation Grasses and Clover.				Permanent Grass.			
	For Hay.		Not for Hay.		For Hay.		Not for Hay.	
	1928.	1927.	1928.	1927.	1928.	1927.	1928.	1927.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	50,719	50,684	245,162	243,657	1,520	883	47,186	42,518
ANGUS	21,950	22,167	61,972	61,283	1,028	1,694	28,475	27,296
ARGYLL	11,928	12,183	15,785	15,082	15,714	16,328	52,059	52,948
AYR	26,508	27,114	47,563	51,192	22,799	22,745	157,351	152,244
BANFF	10,406	9,584	61,320	60,922	547	381	11,835	11,754
BERWICK ...	11,536	11,141	52,727	50,671	3,020	3,762	59,869	57,948
BUTE	2,413	2,294	5,457	5,242	580	497	9,767	10,071
CAITHNESS ...	10,353	9,838	29,998	29,051	1,058	762	23,181	23,811
CLACKMANNAN	1,161	1,282	1,364	1,772	1,379	1,238	6,564	6,192
DUMBARTON ...	4,986	5,112	5,162	4,703	2,555	2,800	22,157	21,789
DUMFRIES ...	20,505	19,341	47,710	50,046	19,484	19,498	101,885	99,278
EAST LOTHIAN	8,726	8,909	17,834	18,244	1,563	1,307	24,751	22,880
FIFE	25,263	25,815	30,356	29,141	4,053	4,159	73,591	72,810
INVERNESS ...	11,131	11,039	21,789	22,662	9,640	9,314	59,749	58,583
KINCARDINE ...	12,618	12,847	35,739	34,989	468	428	11,050	11,005
KINROSS ...	2,864	2,881	8,025	6,481	643	1,000	12,316	13,536
KIRCUDBRIGHT	10,647	10,171	41,072	40,074	13,075	13,272	84,961	86,556
LANARK ...	29,720	30,410	34,960	35,327	14,774	14,264	104,884	104,172
MIDLOTHIAN ...	11,226	11,358	17,640	18,136	1,527	2,108	41,593	39,737
MORAY	5,713	5,753	35,418	34,632	118	131	7,846	7,866
NAIRN	1,617	1,762	9,453	8,932	108	32	1,774	1,781
ORKNEY ...	10,920	10,924	31,418	30,932	966	601	14,774	14,376
PEEBLES ..	2,474	2,360	10,223	11,017	1,364	1,175	27,972	26,870
PERTH	31,996	32,160	61,018	60,139	11,838	11,811	94,549	94,448
RENFREW ...	7,943	8,658	7,215	5,959	6,103	6,519	43,517	44,348
ROSS AND CROMARTY ...	13,166	12,396	35,179	34,176	2,878	3,401	26,292	26,536
ROXBURGH ...	10,262	9,758	51,851	48,912	6,243	6,415	57,968	60,042
SELKIRK ...	1,409	1,298	7,239	7,148	1,984	1,854	13,489	13,456
SHETLAND ...	1,527	1,451	471	518	2,094	1,910	11,218	11,337
STIRLING ...	10,011	10,395	9,734	10,520	9,059	8,551	53,703	52,764
SUTHERLAND ...	4,612	4,598	6,120	5,784	1,550	1,425	7,985	8,124
WEST LOTHIAN	6,373	6,653	5,052	5,520	1,068	1,288	22,377	21,669
WIGTOWN ...	8,070	7,386	53,540	53,877	5,505	5,709	49,099	46,645
TOTAL ...	400,753	399,672	1,105,516	1,096,691	166,300	167,212	1,365,732	1,345,385

NUMBER of HORSES, CATTLE, SHEEP and PIGS in each COUNTY on 4th June 1928, with COMPARISON for 1927.

COUNTIES.	Horses.*		Cattle.		Sheep.		Pigs.	
	1928.	1927.	1928.†	1927.	1928.†	1927.	1928.	1927.
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
†ABERDEEN ...	28,070	23,825	175,198	175,019	326,989	305,207	22,588	27,195
†ANGUS	7,934	7,992	46,341	48,341	196,788	196,493	8,414	7,938
†ARGYLL ...	4,380	4,556	56,073	55,493	747,666	747,885	4,525	4,200
AYR	7,150	7,357	110,328	108,702	399,286	400,111	13,896	13,826
†BANFF	6,662	6,878	42,550	43,961	94,814	89,581	6,681	7,389
BERWICK ...	3,865	3,967	24,893	25,082	382,351	381,092	5,260	4,526
BUTE	986	1,027	8,787	8,802	43,149	44,560	747	742
†CAITHNESS ...	4,413	4,449	20,104	19,971	176,768	174,001	2,147	2,282
CLACKMANNAN	488	532	3,507	3,644	13,750	13,443	756	955
†DUMBARTON ...	1,389	1,398	13,342	13,397	71,012	71,982	1,132	1,221
DUMFRIES ...	5,424	5,702	70,018	68,908	591,050	593,251	12,623	11,511
EAST LOTHIAN	3,097	3,165	13,907	14,188	157,348	153,355	5,794	5,178
FIFE	7,471	7,736	44,765	44,796	132,670	133,383	8,172	8,197
†INVERNESS ...	6,798	7,044	48,846	47,833	515,771	507,196	2,236	2,507
†KINCARDINE ...	3,925	4,091	26,457	26,528	65,106	66,767	3,440	4,227
KINROSS ...	898	955	6,044	6,397	33,821	34,237	1,036	968
†KIRKCUDBRIGHT	3,831	4,093	59,130	58,288	392,564	404,582	18,926	18,421
LANARK ...	6,128	6,522	70,047	70,024	246,358	243,087	10,084	8,158
MIDLOTHIAN ..	2,896	3,099	16,612	17,094	190,864	188,137	15,316	15,482
MORAY	3,935	4,000	23,878	23,902	52,965	53,879	4,741	5,300
NAIRN	1,055	1,124	6,938	6,581	12,755	14,829	849	1,015
ORKNEY ...	5,387	5,493	33,649	32,781	49,404	46,038	2,668	3,427
PEEBLES ...	747	792	6,919	6,895	214,214	209,548	1,187	835
†PERTH	10,189	10,441	69,137	69,796	654,304	662,589	10,688	10,692
RENFREW ..	2,118	2,221	24,396	24,268	46,574	46,967	4,564	3,984
†ROSS AND CROMARTY ...	5,613	5,781	38,383	33,153	323,313	321,189	4,083	4,462
ROXBURGH ...	3,303	3,408	25,359	24,374	584,336	575,557	4,173	4,068
SELKIRK ...	486	502	4,022	3,839	194,075	195,257	589	595
SHETLAND ...	2,411	2,401	11,376	11,530	163,823	154,287	298	259
STIRLING ...	3,336	3,522	33,314	32,993	124,965	128,943	3,288	3,806
†SUTHERLAND ...	1,847	1,921	9,549	9,870	218,266	217,515	669	649
WEST LOTHIAN	1,768	1,785	11,065	11,421	23,876	22,951	2,538	1,900
WIGTOWN ...	4,448	4,667	58,919	57,579	138,259	137,628	16,401	16,248
TOTAL ...	147,448	152,441	1,213,848	1,210,450	7,578,704	7,535,477	195,504	196,613

* Horses used for agricultural purposes, mares for breeding, and unbroken horses (including Stallions). "Other Horses" on agricultural holdings are not included; the total for these in Scotland is given in the summary table on p. 110.

† Including cattle and sheep grazed on Deer Forests.

County and District of County.		Wheat.	Barley (including Bere).	Oats.	Potatoes.	Turnips and Swedes.	Sugar Beet.	Rye-grass and other Rotation Grasses & Clover. For Hay.	Rye-grass and other Rotation Grasses & Clover. Not for Hay.	Permanent Grass. For Hay.	Permanent Grass. Not for Hay.	* Horses	† Cattle.	† Sheep.	Pigs.
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	No.	No.	No.	No.
ABERDEEN	Aberdeen	..	3,288	18,023	1,863	9,435	3	7,163	26,639	383	3,362	2,681	19,767	18,178	5,068
	Alford	..	320	15,893	313	7,445	..	4,853	21,579	233	7,001	2,043	16,246	46,124	926
	Deer	6	1,391	40,091	2,214	16,185	27	12,219	50,038	331	9,881	5,197	39,415	53,501	4,796
	Deeside	6	1,048	14,636	534	6,852	..	5,623	18,560	101	6,224	2,023	15,306	54,149	1,710
	Ellon	..	1,485	26,014	919	11,743	3	7,686	37,750	182	5,564	2,919	25,488	50,895	2,971
	Garioch	..	1,590	22,856	672	10,299	5	5,722	31,623	216	6,015	3,076	23,281	25,122	2,414
	Huntly	..	639	13,932	405	5,962	.	2,656	22,922	57	6,204	1,908	12,007	46,583	1,584
	Turriff	..	1,633	26,425	907	10,670	4	4,797	36,046	17	2,895	3,213	23,789	32,937	3,159
ANGUS	Arbroath	3,130	3,888	9,902	4,324	6,326	21	4,590	10,385	185	3,906	1,063	8,756	8,500	1,459
	Brechin	2,813	4,087	17,714	4,332	9,228	33	6,876	20,228	378	7,786	2,338	13,678	74,775	2,294
	Dundee	3,185	1,515	10,100	4,818	5,664	16	4,214	10,357	145	4,318	1,564	9,067	21,165	2,287
	Forfar	2,899	2,558	17,564	5,176	8,330	42	6,270	21,002	315	12,520	2,369	14,840	92,348	2,374
ARGYLL	Ardnamurchan	..	..	404	206	38	..	575	134	1,224	1,320	151	3,590	62,122	24
	Cowal	..	..	1,141	244	393	..	1,033	656	1,575	6,673	302	4,240	134,306	187
	Islay	2	12	3,627	502	1,151	..	2,932	3,157	1,586	15,686	861	9,947	71,574	696
	Kintyre	..	253	4,516	400	1,972	..	1,675	9,258	1,403	12,084	1,086	13,854	129,276	2,513
	Lorn	..	..	1,858	556	522	..	2,468	865	4,504	5,697	677	9,187	174,415	377
	Mid-Argyll	..	..	1,583	321	458	..	1,681	1,233	3,077	6,606	497	7,309	104,430	487
	Mull	..	549	1,820	485	216	..	1,564	487	2,345	3,998	806	7,946	71,543	391
AYR	Ayr	209	23	9,024	1,717	1,732	..	7,297	18,270	6,939	41,515	1,737	29,217	115,743	4,056
	Carrick	49	41	8,107	3,521	2,598	..	4,998	13,134	8,898	35,347	1,804	24,062	199,386	4,179
	Kilmarnock	565	10	8,763	1,115	1,109	..	7,499	10,636	6,177	43,075	1,827	31,342	37,725	4,171
	Northern	501	3	8,639	2,275	1,174	..	6,719	10,523	5,785	37,414	1,782	25,707	46,382	1,490
BANFF	Banff	14	5,928	25,230	1,384	11,676	12	5,853	35,449	257	2,250	3,922	26,663	31,851	4,824
	Keith	..	717	18,951	508	7,411	..	4,558	25,871	290	9,585	2,740	15,887	62,968	1,857
BERWICK	Eastern	610	4,454	7,727	1,128	6,158	45	3,739	14,879	1,096	19,327	1,298	8,225	102,698	1,842
	Middle	888	5,976	8,796	926	7,047	70	4,999	15,636	872	21,837	1,565	9,529	188,875	2,582
	Western	178	1,346	8,797	410	5,506	10	2,798	23,212	1,063	18,705	1,017	7,139	145,778	886
BUTE	Arran	..	4	2,126	633	391	..	1,125	2,346	248	4,563	516	4,085	32,362	331
	Bute and Cumbrae ..	9	3	2,210	379	770	..	1,288	3,111	332	5,204	470	4,708	19,787	416
CAITHNESS (not divided) .. .		..	583	27,018	1,091	10,427	..	10,358	29,998	1,063	23,181	4,413	20,104	176,768	2,147
CLACKMANNAN (not divided)		236	94	2,848	376	706	..	1,161	1,364	1,379	6,564	488	3,507	18,750	756
DUMBARTON	Eastern	317	4	3,165	1,129	600	..	2,665	2,526	1,167	9,585	702	5,884	12,907	335
	Western	46	1	2,988	1,131	758	..	2,321	2,636	1,388	12,572	687	7,468	58,105	297

:nch

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1928.

County and District of County.		Wheat.	Barley (including Bere).	Oats.	Potatoes.	Turnips and Swedes.	Sugar Beet.	Rye-grass and other Rotation Grasses & Clover.		Permanent Grass.		* Horses	† Cattle.	† Sheep.	Pigs.
								For Hay.	Not for Hay.	For Hay.	Not for Hay.				
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	No.	No.	No.	No.
DUMFRIES	Annan	8	..	11,166	1,057	4,622	..	6,190	13,483	3,604	17,826	1,692	17,128	58,045	2,815
	Dumfries	39	45	8,083	1,093	3,176	..	4,391	11,935	2,359	15,482	1,151	14,116	59,126	3,139
	Langholm	..	..	2,137	159	968	..	1,389	3,032	2,908	8,297	396	5,115	129,065	475
	Lockerbie	3	14	7,381	576	3,174		4,918	11,714	6,179	26,899	1,324	18,157	156,669	1,899
	Thornhill	..	4	5,067	434	2,030	..	3,618	7,546	5,064	38,931	951	15,502	188,145	4,314
EAST LOTHIAN	Eastern	1,369	5,366	4,656	342	4,224	149	2,980	7,048	564	9,680	1,171	4,947	74,908	1,687
	Western	3,801	7,576	9,952	4,674	7,410	296	5,746	10,786	999	15,071	1,926	8,960	82,440	4,157
FIFE	Cupar	3,351	3,541	13,618	6,083	7,208	366	7,316	13,208	943	16,029	2,246	12,513	48,060	2,277
	Dunfermline	1,397	629	6,770	1,812	2,413	23	4,170	3,515	1,359	22,499	1,186	3,775	29,294	1,585
	Kirkcaldy	2,492	3,007	9,186	3,324	4,107	197	6,341	6,108	761	14,878	1,783	10,404	21,700	2,348
	St. Andrews	4,570	4,917	10,892	5,306	6,664	644	7,436	7,525	990	20,186	2,256	13,073	33,016	1,962
INVERNESS	Inverness	8	1,453	6,889	424	3,969	..	2,726	11,126	73	5,061	1,249	7,110	42,568	1,109
	Aird	18	54	5,828	434	2,387	..	2,757	5,543	468	5,743	891	5,796	42,780	672
	Badenoch	..	27	3,638	162	1,524	..	2,171	4,175	1,342	9,828	650	4,686	95,971	266
	Lochaber	1	..	955	406	198	..	1,168	248	2,239	3,046	363	5,148	142,592	129
	Skye	..	2	5,227	1,378	379	..	2,002	535	3,554	5,574	926	11,048	131,595	23
	Harris, N. & S. Uist ..	..	2,186	6,181	2,220	117	..	307	112	1,964	30,477	2,719	15,109	69,270	17
KINCARDINE	Laurencekirk	280	1,068	9,424	1,443	4,135	26	3,194	10,315	52	2,414	1,014	6,368	21,721	1,090
	Lower Deeside	..	644	3,698	781	1,766	.	1,893	3,827	3	637	526	3,306	2,536	671
	St Cyrus	558	1,484	6,001	910	2,957	..	2,335	5,935	66	2,490	724	4,097	13,600	507
	Stonehaven	111	1,839	3,040	394	4,062	8	3,591	9,453	342	4,187	1,068	3,341	18,684	739
	Upper Deeside	..	1,086	3,717	268	2,096	.	1,606	6,209	5	1,322	606	4,345	3,565	436
KINROSS (not divided)		267	99	6,179	1,161	2,246	..	2,864	3,025	648	12,316	898	6,044	33,821	1,036
KIRKCUDBRIGHT	Eastern	10	30	8,241	961	3,383	..	4,484	14,428	3,581	27,871	1,424	20,411	76,314	5,415
	Northern	..	..	1,586	113	654	.	826	2,539	2,959	10,838	408	5,527	145,744	750
	Southern	48	7	8,180	238	3,774	1	4,189	21,842	5,167	34,468	1,670	27,578	87,874	7,130
	Western	..	16	1,734	74	749	..	1,198	2,263	1,368	11,789	329	5,614	82,632	631
LANARK	Lower Ward	704	5	3,562	1,397	530	1	2,519	1,464	2,290	6,977	667	4,857	1,567	4,786
	Middle Ward	1,196	54	16,033	2,490	3,047	.	15,760	12,692	7,588	51,072	2,934	35,561	36,153	3,275
	Upper Ward	43	15	15,759	2,238	5,422		11,441	20,804	4,896	46,835	2,527	29,929	266,638	2,023
MID-LOTHIAN	Calder	1,438	404	5,608	1,732	1,710	8	3,725	2,233	454	13,708	782	4,999	40,159	3,654
	Gala-Water	224	1,041	4,804	399	3,384	1	1,831	11,208	267	14,536	616	3,969	102,980	496
	Lasswade	1,628	1,589	5,711	2,061	2,327	30	3,537	3,878	579	9,289	915	4,644	39,832	2,847
	Suburban	1,937	469	2,996	2,098	1,119	9	2,153	326	227	4,660	583	3,009	7,892	3,319
MORAY (not divided)		915	3,117	23,500	1,708	13,164	68	5,713	35,418	118	7,846	3,935	23,878	52,965	4,741
NAIRN (not divided)		..	1,987	6,278	275	3,740	10	1,617	9,453	108	1,774	1,065	6,938	12,755	849

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1928.

County and District of County.		Wheat.	Barley (including Bere).	Oats.	Potatoes.	Turnips and Swedes.	Sugar Beet.	Rye-grass and other Rotation Grasses & Clover. For Hay.	Rye-grass and other Rotation Grasses & Clover. Not for Hay.	Permanent Grass. For Hay.	Permanent Grass. Not for Hay.	* Horses	† Cattle.	† Sheep.	Pigs.
		Acres	Acres.	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	No	No	No	No
ORKNEY	Mainland		902	17,096	1,215	6,588		6,231	17,181	519	7,815	2,935	17,736	21,261	1,390
	North Isles		2,111	9,824	721	4,547		3,190	10,259	320	5,742	1,762	11,521	21,050	985
	S. Ronaldshay & Walls		291	4,512	317	1,709		1,499	3,978	121	1,217	690	4,392	7,093	296
PEEBLES (not divided)			59	5,239	331	2,681		2,474	10,223	1 364	27,972	747	6 919	214,214	1,187
PERTH	Blairgowrie	2,771	909	14,558	5,847	5,896	38	6,884	15,799	898	13,705	2,112	12,814	61,613	2,048
	Central	672	151	13,969	3,461	4 547	1	6,835	13,534	1,724	19,212	2,178	13,719	131,871	1,978
	Highland	6	35	6,099	786	2,876		4,394	6,206	2,298	14,903	1,154	9,254	200,881	1,233
	Perth	4,010	1,193	19,845	6,496	7,964	98	9,157	17,982	2,006	27,947	2,956	20,170	71,390	3,569
	Western	328	154	8,968	1,687	2,083		4,776	7,548	5,418	18 782	1,794	13,180	188,549	866
RENFREW	First or Upper	977	1	3,729	1,228	812		3,716	2,367	3,521	22,787	994	11,630	21,851	2,801
	Second or Lower	746	3	4,968	2,144	1,041		4,228	4,848	2,582	20 730	1,124	12,766	24,723	1,763
ROSS & CROMARTY	Black Isle	183	2,012	6,553	802	3,925		3,137	9,607	67	2,162	1,124	6,187	16,977	1,153
	Easter Ross	748	1,202	9,110	1,746	4,996		4,036	13,783	162	6,702	1,543	9,257	78,725	1,854
	Mid Ross	99	581	8,647	694	3,984		4,066	11,848	406	6,631	1,439	9,272	81,483	967
	S.-W and Western		30	1,658	577	173		1,529	294	1,523	2,732	316	4,185	74,328	98
	Lewis		1,896	5,593	3,097	132		398	147	720	8,065	1 191	9,483	71,856	11
ROXBURGH	Hawick & Liddesdale	4	24	2,918	153	1,735		1,364	6,252	3,370	11,372	511	5,836	190,645	583
	Jedburgh	165	1,281	6,649	245	4,302	6	2,948	16,394	1,397	18,710	1,021	7,297	164,831	839
	Kelso	837	4,580	7,427	642	6,276	20	3,909	18,082	788	13,770	1,163	7,947	153,302	1,728
	Melrose	114	855	4,892	180	3,132	1	1,951	11,123	688	14,116	608	4,279	76,058	1,083
SELKIRK (not divided)		5	141	3,306	131	1,883		1,409	7,239	1,984	13,459	486	4,022	194,075	580
SHETLAND	Mainland		542	4,948	1,599	852		1,164	397	1,465	8,156	1,554	8,662	124,088	201
	North Isles		11	1,089	395	128		363	74	629	3,057	857	2,714	39,135	97
STIRLING	Central	626	111	6,692	1,356	1,489		3,280	3,781	4,813	18,730	1,427	13,708	44,047	926
	Eastern	729	267	5,677	853	1,061		3,621	2,820	2,418	15,879	1,080	8,804	6,517	1,075
	Western	123	15	4,103	1,154	938		3,110	3,133	1,328	19,094	879	10,802	74,491	1,237
SUTHERLAND (not divided)			215	7,014	1,047	2,518		4,612	6,120	1,550	7,985	1,847	9,549	218,266	869
WEST LOTHIAN	Bathgate	325	144	4,963	716	1,151		3,238	3,001	648	12,832	880	6,245	9,518	604
	Linlithgow	2,160	1,060	5,287	1,821	1,910	11	3,135	2,061	425	9,545	879	4,820	14,363	1,929
WIGTOWN	Machars	17	62	9,129	322	3,806	15	4,928	20,078	4,005	32,228	1,995	27,732	77,000	4,816
	Rhins	7	28	15,366	1,263	6,996		3,142	33,462	1,500	16,871	2,453	31,187	61,259	11,665

* See Note on p. 114

† Including stock grazed on Deer Forests.

BOARD OF AGRICULTURE FOR SCOTLAND,
EDINBURGH, 14th December 1928

Printed under the authority of HIS MAJESTY'S STATIONERY OFFICE
By J. Skinner & Co., Ltd., Thistle Street, Edinburgh.
(7052.) Wt 10841/1288. 1500+49, pp. 101-117. 1.29 J.S.&Co.,Ltd. G. 18.

The Scottish Journal of Agriculture.

VOL. XII.—NO. 2.] APRIL 1929. PRICE 1s. NET.

THE AGRICULTURAL OUTPUT OF SCOTLAND—III.

THE previous articles on this subject have dealt with the changes that took place in Scottish agriculture between 1871 and 1925, and with the distribution of land and live stock per 1,000 acres in the years 1913 and 1925, with particulars of the distribution of labour in the latter year. The amount and value of the agricultural output of the year 1925 form the subject of this article.[1] The actual period covered extends to more than a year. Meat, milk, poultry and eggs are valued for the twelve months June 1924 to May 1925; the farm crops are those produced in 1925 and sold partly in that and partly in the following year; fruit, vegetables and glasshouse produce are valued for the calendar year 1925.

LIVE STOCK PRODUCTS.

The outstanding feature of Scottish agricultural production is the great preponderance of live stock products, which in 1925 accounted for no less than 79·5 per cent. of the total estimated value of the produce sold off farms or consumed in farm households, as compared with 68·6 per cent. in England and Wales.

Meat.—The amount of meat produced in the country is ascertained, not by direct inquiry, but by calculation based on the numbers of each class of stock at the beginning and end of the period under consideration, with allowances for births and deaths and for the importation of store animals from overseas. For this purpose a special inquiry was made as to the numbers of births and deaths of cattle, sheep and pigs on each holding, which supplied the material for general figures. These vary considerably from one district to another, and from one size of holding to another; the details will be found in *The Agricultural Output of Scotland*, page 33 and Appendix Tables 13 and 14. The figures for Scotland as a whole are :—

	Cattle.	*Sheep.*	*Pigs.*
Births (per 100 of breeding stock)	86	102	1,050
Deaths (per 100 of total stock) ...	3·0	5·9	9·2

[1] Some of the figures given here differ from those given in *The Agricultural Output of Scotland*, owing to subsequent revision.

The death-rate among cattle under one year is 7·1 per cent. and that among older cattle 2·0. Sheep show a smaller difference according to age, those under one year having a death-rate of 6·8 per cent. and older sheep one of 5·2. The birth-rate per 100 ewes ranges from 86 in the northern and north-western division to 124 in the south-eastern.

The calculation mentioned above leads to the conclusion that between 1st June 1924 and 31st May 1925 the number of animals sold for slaughter was as follows :—

Cattle	531,000
Calves	90,000
Sheep and lambs	2,472,000
Pigs	242,000

The figures for cattle and pigs are considerably above the average of the preceding four years, and that for sheep slightly above it, while that for calves is lower.

To obtain the quantity of meat produced it is necessary to apply to these figures the average dead weights obtained by inquiry of slaughterhouses, viz. for cattle 672 lb., for calves 75 lb.,[1] for sheep and lambs 50 lb., and for pigs 160 lb.

The meat production thus estimated amounts to 4,665,000 cwt., distributed as follows :—

Beef	3,180,000
Veal	45,000
Mutton and lamb	1,100,000
Pork and bacon	340,000

This represents about 95 lb. per head of the human population, as compared with 47 lb. per head in England and Wales. It is true that in the calculations of slaughter made for the two countries no account was taken of the trade in store stock between Scotland and England; an exact allowance for this trade might result in a reduction in the number of beasts estimated to have been slaughtered in Scotland. It is, however, clear in any case that Scotland produces a much larger proportion of her meat requirements than England; a considerable quantity of beef and mutton is indeed sent across the Border.

The distribution of the various kinds of meat is markedly different in Scotland from that in England and Wales, the respective percentages, on the average for the five years 1920-1 to 1924-5, being as follows :—

	Scotland.	*England and Wales.*
Beef	66·4	46·0
Veal	1·3	4·1
Mutton and lamb	25·7	16·2
Pork and bacon	6·6	33·7

From another point of view, while Scotland produces 29 per cent. of the beef produced in Great Britain and 31 per cent. of

[1] This weight is applied to only two-thirds of the estimated number of calves slaughtered, the rest being taken as "slink" carcases at 20 lbs.

the mutton and lamb, her contribution of veal is only 8¼ per cent. and that of pork and bacon 5½ per cent. As regards beef, it should be noted that half the cattle fattened in Scotland are bred in Ireland, and that Scotland's actual share in the production of beef from these beasts is limited to the addition made during the period of fattening.

The value of the meat thus produced in the year 1924-5 was as follows :—

Beef	£16,300,000
Veal	250,000
Mutton and lamb	8,250,000
Pork and bacon	1,450,000
Total	£26,250,000

This amounts to 53·9 per cent. of the total value of the agricultural output.

Milk and Dairy Produce.—The total quantity of milk produced in Scotland in the year 1924-5, exclusive of that fed to calves, is estimated at 171,000,000 gallons, or 430 gallons per cow as an average for the mean number of cows in milk or in calf at 4th June 1924 and 4th June 1925. On the assumption that 10 per cent. of the total output is used for calf-feeding, the average total production per cow is about 480 gallons. This figure is perhaps lower than would generally have been expected. Owing, however, to the fact that the returns made by farmers on this subject were in many cases imperfect, the figures are presented with some reserve.

No less than 59 per cent. of the total quantity of milk was produced in the western and south-western division, in which the output of milk per acre of land under crops and grass was 66 gallons, as compared with 22 gallons in the rest of the country. In this division nearly 93 per cent. of the milk produced was sold as whole milk, butter, cheese or cream, while in the northern and north-western division the proportion so disposed of was under 42 per cent., the average for Scotland being 81·8 per cent.

The quantity of whole milk sold by farmers is estimated at 114,000,000 gallons, while they made 5,850,000 lb. of butter, of which they sold 3,260,000 lb., and 145,500 cwt. of cheese, of which they sold 135,000 cwt. On the basis of 2·7 gallons of milk per lb. of butter and one gallon per lb. of cheese, the quantity of milk used for the former is 15,700,000 gallons and that for the latter 16,300,000 gallons. The quantity of cream sold is estimated at 824,000 quarts, which at 10 quarts of milk per quart of cream requires 2,100,000 gallons of milk. The cheese produced in the western and south-western division was 94 per cent. of the total, but in butter its predominance is less marked, its proportion being 38 per cent. as compared with 26 per cent. in the north-eastern division.

Details of the production of milk and its products in each division of Scotland and on each of the groups of holdings are

given in the text and Appendix Tables 15 and 16 of *The Agricultural Output of Scotland*.

The value of the milk and dairy produce of Scotland in the year 1924-5 was as follows :—

Milk	£7,500,000
Butter	520,000
Cheese	780,000
Cream	100,000
Total	£8,900,000

This amounts to 18·3 per cent. of the total value of the agricultural output.

Poultry and Eggs.—The total production of fowls' eggs is estimated at 239,100,000, or 100 per hen hatched before 1925, as compared with 72 (for Great Britain) in 1908, and 84 (for Scotland) in 1913. Progress has been made in the last twenty years, but an average of two eggs a week per hen shows that a large proportion of the poultry kept is still of poor laying capacity.

The total production of ducks' eggs is estimated at 9,500,000. Thus the total number of eggs is nearly 250 million, a considerable proportion of which is consumed on the farms. If the whole supply were available for general consumption, it would give each person in Scotland one egg a week. What amount should be added to this for eggs produced by poultry not included in the Department's returns has not been ascertained, but even if this additional amount were 20 per cent. of the total given above, there is obviously room for considerable expansion of egg production.

The quantity of poultry sold for food is estimated at 2,400,000 fowls, 90,000 ducks, 13,500 geese and 50,000 turkeys.

The value of this produce is estimated as follows :—

Fowls' eggs	£1,600,000
Ducks' eggs	50,000
Fowls	565,000
Ducks, geese and turkeys	65,000
Total	£2,280,000

This amounts to 4·7 per cent. of the total value of the agricultural output.

Wool.—The number of occupiers returning flocks of over 500 sheep in 1925 was 3,750, and they were asked to give particulars of the number of sheep shorn in 1925, the total quantity of wool clipped, the total sum realised for the wool, and whether it was washed or unwashed, the breeds and classes of animals being distinguished in each case. The replies received and used were nearly half of those issued, and they covered about one fourth of the total number of sheep over one year old.

The total amount of wool clipped is estimated at 20,500,000 lb., of which 5,400,000 lb. were washed and 15,100,000 lb. were

unwashed. The average weight of the washed fleeces was 4½ lb. and that of the unwashed 5 lb., and their respective values per lb., 1s. 3d. and 1s. The estimated total value of the clip is £1,100,000, of which £350,000 was received for washed wool and £750,000 for unwashed. This amounts to 2·3 per cent. of the total value of the agricultural output. The weight of skinwool at 2½ lb. per fleece is estimated at 6,000,000 lb. Its value is included in the value of mutton and lamb.

Farm Crops.

The produce of the principal farm crops is estimated annually by the Department. Hence in dealing with these crops in the Census of Production the only special inquiry that was necessary was one relating to the proportions of the various crops that were sold off the farms. No account was taken of crops consumed by live stock, since the value of these is included in that of the stock as ultimately sold. The Department's Crop Reporters were asked to estimate for their respective districts the proportion of each crop sold off the farms or consumed in the farm households, and the following are the weighted averages of these estimates, stated as percentages of the total crop in each case :—

Wheat	82	Rotation hay ...	33
Barley	78	Meadow hay ...	8
Oats	40	Wheat straw ...	15
Potatoes	78	Barley straw ...	5
		Oat straw ...	5

Special inquiry was made as to the output of the minor crops of sugar beet, flax and grass seed, and these are included in the following table, which gives the quantity of each kind of produce sold and its estimated value :—

	Tons.	*Value.*
Wheat	44,000	£535,000
Barley	112,000	1,230,000
Oats	285,000	2,850,000
Potatoes	775,000	3,100,000
Sugar beet	11,500	25,000
Flax	1,200	10,000
Rotation hay	213,000	1,060,000
Meadow hay	20,000	90,000
Wheat straw	12,000	35,000
Barley straw	8,000	25,000
Oat straw	53,000	160,000
Grass seed	3,000	60,000
Total value		£9,180,000

This amounts to 18·9 per cent. of the total value of the agricultural output. The proportion accounted for by farm crops in

England and Wales is 20·5 per cent. When allowance is made for hops, and for the fact that the acreage of sugar beet in England and Wales is relatively much greater than that in Scotland, it is found that the contribution made by ordinary farm crops is much the same in the two countries.

FRUIT, VEGETABLES, &c.

These form an insignificant part of the output, the total estimated value of this class of produce being £825,000, or 1·6 per cent. of the total value, as compared with 10·9 per cent. in England and Wales.

Fruit.—The acreage returned in 1925 as under small fruit was 7,189 acres, including 2,477 under strawberries, 3,152 under raspberries, 1,126 under currants and gooseberries, and 434 under mixed crops. Inquiries, however, elicited the information that only 6,200 acres, or 85 per cent. of the total area, were actually in bearing in 1925. Half the area under strawberries was in Lanark, and 90 per cent. of that under raspberries in Perth and Angus, while Lanark and Perth had about half the area under currants and gooseberries.

The estimated produce of each kind of fruit is as follows :—

	Cwt.
Strawberries	51,500
Raspberries	84,500
Black currants	1,570
Red and white currants	2,080
Gooseberries	13,850
Mixed	5,150
Total	158,650

Orchards are of little importance in Scotland. While the acreage under small fruit is 10½ per cent. of that in England and Wales, a ratio approaching that of the human population, the area under orchards, 1,163 acres, is only one half per cent. of that in England and Wales. Here again Lanark and Perth show a marked predominance, accounting for 752 acres, or 65 per cent. of the total area. The produce of these orchards was estimated on the basis of returns received from a proportion of the growers, and the figures are presented with the same reserve. They are as follows :—

	Cwt.
Apples	4,650
Pears	1,085
Plums	3,150
Cherries	350
Mixed orchards	2,375
Total	11,610

Vegetables.—The area on which cabbages were grown for human consumption was about 3,000 acres, and the total produce is estimated at 45,000 tons, while greens amounted to 8,500 tons, grown on about 700 acres. It is estimated that 1,000 acres of turnips were used for human consumption, the total produce being 10,000 tons. Carrots, grown on 275 acres, gave a produce of 1,800 tons, peas, with 400 acres, one of 1,000 tons, onions, with 139 acres, one of 770 tons, and leeks, with 295 acres, one of 2,400 tons, while other vegetables amounted in all to about 3,000 tons. The acreage of rhubarb was 694, and the estimated produce 5,600 tons.

Miscellaneous.—Inquiries were issued to 694 owners of greenhouses, of whom 316 replied, but only 144, or 21 per cent. of the total number, furnished sufficient particulars for tabulation. It is estimated that the total area under glass in Scotland in 1925 was 70 to 80 acres, of which three-fourths were used for tomato-growing, much the greater proportion being in Lanark. The total output of tomatoes is estimated at 2,000 tons, valued at £100,000, while the output of other glasshouse produce is valued at £20,000.

About 200 acres were devoted to the production of flowers, and the value of the produce is estimated at £20,000.

Through the co-operation of the Scottish Beekeepers' Association, the Department were enabled to send forms of inquiry to over 9,000 beekeepers. Of the 5,570 replies received, 3,078 were used. The estimated output on the basis of these returns is 220,000 lb., but it is impossible to say how far this statement covers the output throughout the country.

The estimated value of these products is as follows :—

Fruit	£400,000
Vegetables	165,000
Glasshouse produce	120,000
Flowers	20,000
Honey	20,000
Total	£825,000

Summary.

As has already been pointed out, live stock products account for no less than 79·5 per cent. of the total agricultural output of Scotland in 1925. Beef alone contributes one-third of the total, and mutton and lamb about one-sixth, while more than one-sixth is accounted for by milk and its products. Poultry and eggs bring in about five per cent. of the grand total; their value considerably exceeds that of wheat and barley (as sold) put together, and is equal to four-fifths of the return from the sale of oats.

Of the farm crops, potatoes come first with about one-third of the total value under this head, and 6½ per cent. of the grand

total. Oats are not far behind with 5·9 per cent., while wheat and barley together account for 3·7 per cent., and hay and straw for 3 per cent.

The total value of the agricultural output is about £48,700,000, which is equal to £9, 7*s*. 6*d*. per acre of land under crops and grass, after allowance has been made for the use of rough grazings for the maintenance of sheep. It is further equal to £270 per person engaged in the agricultural industry, including employers and those working on their own account. These figures express the total gross estimated value of produce sold off farms or consumed in farm households. Mention has already been made of the fact that credit is taken for the total production of beef, including the contribution made by Ireland in the breeding of half the cattle fattened in Scotland.

No attempt has been made to estimate the " net output " of Scottish agriculture. This is comparatively easy in the case of manufacturing industries, which deal with raw or semi-manufactured material, and carry out either an intermediate or a final stage in the conversion of this into consumable goods. Owing, however, to the peculiar conditions of the industry, the conception of " net output " is of doubtful validity in the case of agriculture.

The figures here presented constitute only a part of the material required for an assessment of the economic results of farming in Scotland. Other methods of inquiry than that of a general Census of Production are necessary for this purpose, and these methods are now being followed by the Department of Agriculture for Scotland in their scheme of economic investigation, with the co-operation of many farmers engaged in various forms of agricultural activity throughout Scotland.

RECLAMATION OF MOSS LAND IN DUMFRIESSHIRE.

JOHN GILLIES, N.D.A., N.D.D.,
The West of Scotland Agricultural College.

IMMEDIATELY east and south-east of the town of Dumfries lies a great track of peat, or flow, moss, probably the most extensive track of moss in Scotland south of the Highland Line. The general name of Lochar Moss is given to this area because it is intersected and drained by the river Lochar, but different sections of it are named more specifically Craigs Moss, Racks Moss, Ironhirst Moss, Longbridge Moor, &c., and each of these sections may extend to anything between 1,000 and 2,000 acres. Originally it must have been an almost impassable morass stretching from the village of Locharbriggs to the Solway Firth, a distance of approximately nine miles, with an average width of from 1½

to two miles. The total area could not have been less than 16 square miles.

In more recent times, however, it has been intersected towards its northern extremity by two thoroughfares, the Dumfries and Lockerbie road, and the Dumfries and Carlisle road, and by the L. M. and S. Railway; and at its southern extremity by the shore road from Ruthwell to Caerlaverock. Near the town of Dumfries and along the three thoroughfares mentioned a considerable amount of reclamation has been slowly but surely accomplished by private enterprise, and quite a large area is now under cultivation or under grass. At the present time the name Lochar Moss is practically restricted to the almost primeval area of at least 10 square miles which lies south and west of the railway.

This extensive area of moss lies in a natural basin which must have been either estuarine or lacustrine in origin, but its origin is a problem the solving of which may be left to the geologist.

Its physical features, however, must be carefully studied by those propounding any scheme of reclamation. The general surface is remarkably level, with variations of only a few feet in eight or ten miles. It is drained by the river Lochar and its affluents, the Wath burn, Mouswald burn, Black Grain, Dubbins burn, Willow burn, and by other smaller streams and ditches. These streams follow the deeper hollows and consequently are lower than the general surface of the moss, but any decided "fall" into these streams is confined to a narrow strip along each side where the moss has either been washed away or cut away or has subsided. Each section of the moss forms a more or less independent "floor" of from 1,000 to 2,000 acres with a very level but gently undulating surface, and with a depth of pure peat down to 30 feet or more. The undulations are so gentle as to be almost imperceptible, and the surface is remarkably rough and wet.

It is almost certain that the underlying deposits, clay, sand, &c., are far from level, probably much less level than the surface of the moss, and, if they could be denuded of the moss, that their contour would resemble the "merse" land found in the estuaries of the Nith and Lochar. The surface contour is hardly likely to agree with the contour of the underlying deposits; consequently the surface drainage will not follow the same natural lines as the under drainage. This may explain why some parts of a "floor" may appear much wetter and softer than other parts although they may lie adjacent to each other and resemble each other in all other respects.

On the east side of the Lochar in the parish of Torthorwald there exists a curious feature, an alluvial deposit of fine red soil (the wash of flood water from the hills) lying on the peat. This forms meadow land of some value, but its value would be greatly enhanced if the water-table were lowered by cleaning the Lochar effectively further down.

The Ordnance Survey maps show that practically the whole moss lies between 30 feet and 50 feet above high-water mark, but probably the effective "fall" for gravitational drainage is much less than the smaller figure. The effective fall over each independent "floor" is not great, and the problem of draining any large area by gravitational methods is simply to take advantage of every inch of available "fall" and to lead the water into the various streams and ditches at the most suitable places. Probably every "floor," no matter how extensive, could be effectively open-drained.

Any scheme of drainage that involves pumping, or any scheme which entails the complete removal of the moss, opens up problems of an entirely different kind, and is quite outwith the scope of the present investigation. It should not be overlooked, however, that the surface of the underlying deposits must be almost down to sea level if it is not actually below it in places.

In 1920 the Board of Agriculture for Scotland decided to initiate a small preliminary scheme of reclamation to test the practicability of embarking on any larger scheme of reclamation on economic lines. A small area of 2½ acres similar in every respect to the general body of the moss, and offering exactly the same problem with regard to gravitational drainage, and typifying the whole moss, was laid off on the Board's land on Mid-Locharwoods. This area was open-drained in 1920, the drains were deepened and three-fifths of area tiled on oak wood soles in 1921. Treatment with lime was begun in 1921 and with manures in 1922. The area has been under treatment and observation since.

The natural vegetation on the moss was carefully examined and analysed and the examination showed the paucity of its flora, a remarkable feature being the total absence of grasses. The natural Order Gramineæ is not represented. The great bulk of the herbage is made up of the following species:—Heather (*Calluna Erica*), Cross-leaved Heath (*Erica Tetralix*), Hare's-tail Cotton-grass (*Eriophorum vaginatum*), Narrow-leaved Cotton-grass (*Eriophorum angustifolium*), Deer's Hair (*Scirpus cæspitosus*), Bog-Myrtle (*Myrica Gale*), Bog-Asphodel (*Nartheccum Ossifragum*), White Carex (*Carex alba*), with abundance of sphagnum moss and other mosses. If looked for carefully the following can also be found:—Sundews (*Drosera rotundifolia* and *intermedia*), Marsh Andromeda (*Andromeda polifolia*), Cranberry (*Schollera Occycoccus*), White Beak-rush (*Rynchospora alba*). It is evident that the natural vegetation afforded no scope for improvement by means of drainage and the application of lime and manures. Heather and heath are slowly but surely destroyed by application of lime and manures, but the Cotton-grasses and Deers-hair appear to be strengthened by similar treatment. These four species make up the total herbage that has any agricultural value, and although all of them are responsive to drainage only two are responsive to manurial treatment.

A great deal of reclamation work on moss has been done in this and other countries, but many of the essential principles of treatment have never been properly and definitely established. Once the best methods of treatment have been properly worked out it is comparatively easy to decide if the reclamation of any extensive area is likely to prove economic.

There are obviously two possible lines of progress: (1) drainage followed by cultivation, liming and manuring, and (2) drainage followed by liming and manuring but without cultivation. In the second case the aim is simply to improve the grazing value of the moss, and some method of introducing a better type of herbage must be adopted. If the moss is too soft for effective horse labour, cultivation is never likely to be economic.

The first area was laid down and treated not with a view to proving the economic possibilities of reclamation, but rather with a view to establishing definitely the following important considerations which must be factors in any scheme of reclamation.

1. Which form of lime, oxide or carbonate is most effective?

2. Which form of phosphate, or combination of phosphates, is most effective?

3. Whether is lime or phosphates the more potent factor?

4. What is the value of lime without phosphates?

5. What is the value of phosphates without lime?

6. Is potash an important factor?

7. Is nitrogen, as supplied in concentrated nitrogenous manures, an important factor?

8. What is the value of dung, an organic substance applied to an accumulation of organic matter?

9. What part does inoculation by desirable bacteria from dung or fertile soil play? It must be borne in mind that moss like that under consideration can have no bacterial flora comparable to that of a fertile soil, or even fertile reclaimed moss.

10. What is the effect of lime, or phosphates, or potash, or nitrogen or dung on (*a*) the natural herbage of the moss, and (b) any grasses, clovers, &c., introduced and established on the moss?

11. Can grasses and clovers, &c., be introduced and established by surface seeding without resorting to cultivation?

12. Is cultivation, or improved grazing without resorting to cultivation, the more hopeful method of economic reclamation?

13. What is likely to be the minimum effective dressing of lime or manures, or dung or soil?

It is not claimed that an answer has been found to all these questions, but useful information has been gained on every point,

and much valuable and accurate information secured on many points.

The area selected and tile drained was divided into four sections, and as the moss was found too soft for horse labour no cultivation has been attempted. The investigation has been restricted to an attempt to improve the original herbage, and to introduce a better type of herbage by seeding on the surface with grass and clover seeds. As a preliminary step towards this end the whole area was carefully burned over in April 1920.

First Section.—The various plots on this section were treated with a view to testing the effectiveness of—

(1) lime oxide and ground limestone, alone and in conjunction with basic slag and mineral phosphate.
(2) basic slag and mineral phosphate in conjunction with lime and limestone,
(3) potash,
(4) dung and earth top-dressed,
(5) seeding with grasses and clovers on the surface without cultivation.

Treatment was begun in 1922 by the application of the lime, phosphates, potash and dung. Seeds were sown in 1923, and earth and more potash in 1924. The dressings were applied at the following rates :—

Shell Lime	4 tons per acre.
Ground limestone	4 ,, ,,
Basic slag 30 per cent.	10 cwt. ,,
Mineral phosphate	$5\frac{1}{2}$,, ,,
Kainit	4 ,, ,,
Potash salts	2 ,, ,,
Dung	20 loads ,,
Earth	10 ,, ,,

Second Section.—The various plots on this section were treated with a view to testing a wider range of phosphatic manures in conjunction with different forms of lime, and also of further testing the effect of potash, of dung, of earth and of surface seeding with grasses and clovers. Three kinds of lime were used, viz. :—

By-product carbonate of lime ...	5 tons per acre.
Ground limestone	5 ,, ,,
Ground shell lime	3 ,, ,,

These lime plots were cross dressed with the following six types of phosphate. In each case the amount of phosphate applied was equal to a dressing of 10 cwt. of 30 per cent. basic slag.

Basic slag 30 per cent.
Basic slag 24 per cent.
Mineral phosphate (100 sieve).
Mineral phosphate (120 sieve).
Peerless " A " phosphate.
Peerless " B " phosphate.

Strips across each of the three lime plots (consequently each of the six forms of phosphate) were dressed separately with dung and with earth and the whole area seeded on the surface with grass and clover seeds. Half of each plot dressed with phosphates was also dressed with 30 per cent. potash salts. After the first summer it was evident that the synthetic phosphates—Peerless "A" and Peerless "B"—were markedly more effective than either basic slag or mineral phosphate. These synthetic phosphates are a Belgian product, seldom seen on the British market, and were kindly supplied by M. Van de Plaer.

Third Section.—This section was laid down on the suggestion of Professor M'Arthur of the West of Scotland Agricultural College. Recent work on plant metabolism by Professor M'Arthur would appear to show that application of equivalent weights of phosphoric acid is not an absolutely sound basis of comparison, but that a knowledge of the molecular composition of the manures is likely to give information of more fundamental value.

Five plots of equal size were laid down and were dressed with the following manures in 1924 :—

1. 40 lb. high grade slag of high citric solubility containing 17·3 per cent. P_2O_5. This is an open-hearth basic slag made without the use of fluorspar, the phosphates present being silico-phosphates.
2. 224 lb. low grade slag of low citric solubility containing 7·6 per cent. P_2O_5. This is an open-hearth slag supplying phosphate in the form of "apatite," and also supplying di-calcium silicate, the calcium of which was extremely soluble in a weak solution of citric acid.
3. 40 lb. Peerless phosphate of high citric solubility containing 17·6 per cent. P_2O_5. This is a synthetic silico-phosphate. It contains a new silico-phosphate first identified by Scott and M'Arthur in high-grade highly soluble Bessemer basic slag.
4. 30 lb. Constantine mineral phosphate containing 30·2 per cent. P_2O_5.
5. Limestone supplying same weight of calcium as the slag applied to plot 2.

The four plots dressed with phosphates received no lime in any form, and the plot dressed with limestone received no phosphate of any kind. The effect of the low grade slag applied to plot 2 was very rapid and very marked. During the summer of application the herbage on this plot improved almost beyond belief.

Plot 3 dressed with Peerless phosphate improved markedly and only a little less rapidly. Plot 1 dressed with high grade slag made quite a visible improvement in the year of application, but it was obviously only taking third place. Plot 4 dressed with mineral phosphate made an improvement which was quite obvious, but the improvement was relatively slow and rather

indefinite. Plot 5 dressed with limestone has made no visible improvement since the limestone was applied over four years ago. These plots were accidentally burned over in April 1927, and the recovery of the herbage after burning was astonishing. Within a few weeks' growth was again vigorous, while the adjacent section lay " dead " and unresponsive during the whole summer. These plots constitute the spectacular part of the whole area and will probably prove the most educative. They appear to show that if phosphates of certain chemical composition, or certain molecular structure, are used, lime might almost be dispensed with, and they also confirm the impression already formed that lime alone is of little value in reclamation work of this kind.

Fourth Section.—The work done on the first three sections was more or less experimental, and on this section the various substances were applied on a more economic basis. Lime was applied as follows :—

3 tons ground limestone per acre.
2 tons ground shell lime per acre.
2 tons ground limestone and 1 ton gypsum per acre.

These lime plots were cross dressed with the following phosphatic manures containing total phosphates equal to 9 cwt. 40 per cent. basic slag per acre.

Basic slag, 40 per cent.
Mineral phosphate.
Bone flour.
Superphosphate.
Sulphurophosphate.
A mixture of the first four.

The whole of this section was also dressed with potash salts at the rate of 3 cwt. per acre. The lime was applied in 1925 and the manures in 1926. The time is still too short for the manures on this section to have had their full effect, but superphosphate has proved itself most effective so far.

Up to the present it has been found impracticable to graze the plots because of the small total area and the absence of pure water, and as the herbage could not be cut and weighed, the results are judged by observation only.

Lime and Limestone.—Liming has always been considered one of the first and most essential steps in moss reclamation, and almost without exception shell lime has been the form used. The experience gained here, however, is rather favourable to the limestone (or carbonate) form. Hot lime was applied in both the shell (to be slaked on the ground) and the ground form, and in both cases the action of the moss on the lime was peculiar and characteristic. Almost immediately the lime comes into contact with the moss it forms into small nodules or lumps of various sizes and must, in consequence, lose a good deal of its virtue. Once it becomes nodular it apparently becomes more or less inactive and disappears very slowly. The shell lime applied to

the first section six years ago is still quite visible on the surface of the moss. The ground shell lime applied in 1924 and 1925 shows the same reluctance to disappear.

Carbonate of lime was applied in two forms : (1) the ordinary limestone form, and (2) the by-product form. In neither case did it show the least tendency to become nodular, and in both cases it had completely disappeared in a few months.

Notwithstanding the characteristics noted above, the oxide or hydrate and the carbonate appeared to be equally active when used in conjunction with phosphatic and other manures, and equally inactive when used alone.

Lime, in any form, used alone appears to be of very little value. It has brought about no material beneficial change in the natural herbage, and has had very little effect in depressing the growth of heather and heath. After the plots have been burned over those that have received nothing but lime in some form have recovered much more slowly than those that had been manured as well as limed. The absolutely " dead " appearance of the former is very marked, while the latter spring to life again within a few weeks after burning.

The conclusions are (1) that no real reclamation is possible by using any form of lime alone; (2) that lime is an essential for permanent reclamation if it is used with phosphatic manures; (3) that any form of lime which can neutralise acidity can be used successfully in reclamation; (4) that ground limestone is the best form because it is cheap, easily handled, easily distributed, and for other reasons already given. There are evidences, however, that phosphates in certain chemical combination might obviate the necessity for heavy dressings of lime in any form.

Phosphatic Manures.—A fairly wide range of phosphatic manures has been tested in conjunction with the different forms of lime, and also without lime in any form. Some of these, however, are hardly likely to be used in any economic scheme of reclamation either because they are too expensive, like bone flour, or because supplies are difficult to secure, as in the case of " Peerless " phosphates. Others, like sulphurophosphate, have not shown sufficient results to justify their use on a large scale. For reclamation on any large scale it is almost certain that the phosphatic manures used would be restricted to the various grades of basic slag, to mineral phosphate, superphosphate and perhaps Nauru phosphate, unless low grade slag and synthetic phosphate containing di-calcium silicate or active silico-phosphate are available at an equally cheap price.

Section three, where the phosphatic manures were used without lime, has proved conclusively that phosphates are a far more potent factor in reclamation than lime. On all the plots dressed with a phosphatic manure alone the improvement in the natural herbage (the cotton-grasses and deer's hair) was immediate and marked, while the grass and clover seeds sown on the surface germinated rapidly and robustly, and the young

plants soon gained a firm hold and appear well established. When burned over in the spring these plots made a marvellous recovery, and within a few weeks the herbage, both natural and introduced, was growing vigorously. The adjacent plot which received limestone only had shown no change in herbage and when burned over made no recovery.

The most effective phosphatic manure when used alone was undoubtedly the very low grade (7 per cent.) basic slag. To supply phosphatic matter equivalent to the 40 per cent. slag used on an adjacent plot almost six times the quantity had to be applied, and in consequence a much greater quantity of lime in the form of di-calcium silicate and other mineral substances would also be applied. The response on this plot was immediate and very marked. Next to the 7 per cent. slag the Peerless "A" phosphate was the most effective, then came the 40 per cent. slag, the mineral phosphate and the Nauru phosphate, all very much alike but probably in the order named.

Basic Slag and Mineral Phosphate.—After some years have elapsed there is evidently little to choose between these sources of phosphate. In every case the slag proved a little more rapid in its action, and the natural herbage responded more markedly to the slag than it did to the mineral phosphate; but on the other hand the introduced herbage appeared to establish itself rather more rapidly and quite as permanently on the mineral phosphate plots, and on the first section, after six years, it is practically impossible to distinguish between the two series of plots.

It would be drawing a very fine distinction to attempt to class the results obtained from the three ordinary commercial grades (24 per cent., 30 per cent. and 40 per cent.) of basic, or to distinguish between the results got by mineral phosphates of the two commercial grists. In reclamation work where the expense of haulage and distribution is disproportionately high the concentrated manure of small bulk will always be preferred if equal, or nearly equal, results can be anticipated. The very low grade (7 per cent. to 10 per cent.) basic slag might be an exception if large quantities were available at a low price.

The Peerless Phosphates.—Two grades ("A" and "B") of these synthetic phosphates were tested, and undoubtedly they proved more effective than any other phosphatic manure with the exception of the very large dressing of 7 per cent. basic slag. These were used with ground lime, with limestone and with by-product carbonate of lime, while, as already mentioned, "A" was tested without lime in the third section. The natural herbage responded rapidly to these manures, but what was more remarkable is that the grasses and clovers sown on the surface germinated better on these plots than on any other part of the whole area, except where dung was used. Peerless "A" proved a little better than Peerless "B." If these two manures were available at a low price they would certainly take an important place in the reclamation of moss.

Superphosphate.—This phosphatic manure was not tested until the fourth section was manured in 1926, when one of the plots was dressed with superphosphate on the top of lime, of limestone and of limestone and gypsum. Superphosphate has not been tried without lime. Its relatively high price and so called acid nature have caused it to be regarded with little favour for reclamation purposes. This was probably an error of judgment, as it is the only phosphatic manure that is soluble and diffusable, and on this fourth section it is the outstanding plot after two seasons of growth. It is the natural herbage that has responded so markedly. The grass and clover seeds have perhaps germinated more robustly on other plots.

Sulphurophosphate and Bone Flour.—Sulphurophosphate or bone flour did not prove very effective.

Potash.—Moss land is usually very deficient in potash, and applications of potash might be expected to give quite visible results. In this case, however, either Kainit or potash salts, used with almost every combination of lime and phosphates, gave negative results. Observation, unconfirmed by accurate data, is perhaps not reliable ground on which to base conclusions, but the fact remains that potash, no matter how it was used, has given no results visible to the eye. It would be unsafe to conclude, nevertheless, that potash is of no value in moss reclamation. It is almost certain that it will be an active factor, especially in the later stages of reclamation work.

Nitrogen.—It was considered possible that the great natural supply of nitrogen in the moss might not be sufficiently active to permit of the lime and manures acting with sufficient rapidity, and both sulphate of ammonia and nitrate of soda were tried on the first section but the results were negative.

Dung.—Dung is scarcely likely to be available for reclamation work on a large scale, and even although it was available it would be expensive and difficult to handle. It was realised, however, that the reclamation of moss is not altogether a matter of draining, liming and manuring, but that these must be accompanied by the development of proper bacterial flora. Dung was likely to be the best agent for introducing desirable bacterial life, in addition to being a complete manure in itself. Dung therefore was tested in conjunction with every combination of lime and manures on the first and second sections. The results were almost spectacular, and quite overshadowed any other results obtained. It proved to be by far the most active agent in reclamation. The heather, heath and other less important plants disappeared in two seasons; the cotton-grasses and deer's-hair appeared to be refined as well as stimulated, and the grass and clover seeds sown on the surface germinated with astonishing rapidity and vigour. Wherever dung was applied the improvement was rapid and very marked. One rather serious objection to the use of dung is that it may introduce a variety of objectionable weeds, docks, thistles, rag-weeds, daisies, weed grasses and many other perennials, not to speak of a host of annuals like

groundsel, chickweed, spurry, &c. It may not be possible to dung moss under reclamation, but the same, though relatively slower, manuring and inoculating effect might be obtained if the moss were grazed by stock introduced at intervals from fertile arable or pasture land.

Earth.—A light dressing of fertile soil was tested on the first and second sections. The results were not very definite. There were slight evidences of bacterial activity evinced in the germination and growth of the white clovers sown, but no other effects have manifested themselves so far. As an inoculating and fertilising agent it proved so inferior to dung as to make the two scarcely comparable.

Surface Seeding with Grasses and Clovers.—Cultivation being found impracticable it became necessary to find other means of establishing a useful grazing herbage. Seeding on the undisturbed surface of the moss appeared the simplest and most natural way of improving the herbage if the seeds sown were certain to germinate and establish themselves. Surface seeding, accordingly, was tried on all the four sections with varying success. The results may be summarised briefly.

1. Wherever dung is used in conjunction with lime and manures, the seeds, both grasses and clovers, germinate with great rapidity and wonderful strength. Where the dung is used in conjunction with lime only the germination is much less active.

2. The dressings of earth appear to help the germination and establishment of the seeds just a little.

3. Where the moss has been treated with lime and manures, germination takes place freely, but neither so freely nor so strongly as on the dunged plots.

4. On the untreated moss the seeds refuse to germinate at all. This was tested on the second, third and fourth sections before these had been treated with lime and manures.

5. On the third section the seeds germinated freely and strongly on the four plots dressed with phosphates only, but on the fifth plot dressed with limestone only they practically refused to germinate.

In almost every case the seeds were sown in July after the moss had benefited by the summer's heat and when there was a likelihood of showers of warm rain. They appeared to sink naturally into the fibrous surface of the moss; the dry sphagnum moss proved an ideal seed bed, and inside three weeks both grasses and clovers showed a braird on the plots favourable to germination. It is a pleasing and unusual sight to see red clover, white clover and a variety of grasses growing through the natural herbage and amongst the sphagnum moss. On the first two plots dunged the grasses and clovers have now been established for five years. These do not appear to suffer as much from the winter frosts as might be expected.

It is evident that a good herbage of mixed grasses and clovers can be established if the conditions are made favourable, and the only question to decide is whether the conditions can be made favourable at a cost that is ever likely to prove economic.

In seeding the various plots no very definite seed mixture was used. It was by no means certain that the seeds sown would ever germinate, and it was thought best to include the seeds of practically all grasses and clovers used in ordinary Scottish practice and to note carefully those that appeared most adaptable. Rough-stalked and smooth-stalked meadow-grass, Dogstail and the smaller fescues were used more freely than the larger grasses. Of the larger grasses Cocksfoot appears to do best, but Italian and Perennial ryegrass and tall and meadow fescue germinate freely and seem to establish themselves without difficulty. For some reason Timothy proved disappointing. Only a small percentage appeared to germinate and it established itself badly. Of the small grasses the two meadow grasses proved the most adaptable. Dogstail, like Timothy, was disappointing. The small fescues did fairly well.

It is doubtful if the policy of attempting to establish grasses with a high fertility requirement on poor soil of any kind is sound. It is probably often better to make use of grasses with a lower fertility requirement, Agrostis for example, and feed them well. An Agrostis pasture well limed and manured is not necessarily a poor pasture on very poor land.

Various types of Red Clover, Alsike, Common White and Wild White Clovers were sown. Alsike was hardly ever in evidence, even for a short time, but the Red Clovers germinated freely and many plants survived two winters. The White Clovers, however, have grown very freely and, especially on the firmer and more solid parts of the moss, appear to be permanently established. Anything which would help to consolidate the moss, such as tramping by stock, would be of great value in helping to establish both grasses and clovers.

In any scheme of reclamation a great deal of trouble will be caused by the Rose-boy willow-herb (*Epilobium angustifolium*). This handsome plant often appears, along with foxglove, when woods are cut down. It has a strong creeping rhizome and spreads with great rapidity. It is not found on the natural moss, but it is only too common wherever reclamation has been attempted. The seeds are wind-borne, and great stretches of Lochar Moss must be thoroughly impregnated with them. As soon as an area was drained, limed and manured, the seeds germinated and the young plants grew and spread with marvellous rapidity. Unless strong steps were taken to repress it, it would soon occupy the moss to the exclusion of everything else. It is a real menace to reclamation.

Summary.—(1) No reclamation is possible without effective drainage.

(2) Any type of lime which can neutralise acidity will be

effective in moss reclamation, but no type has been more effective than ground limestone.

(3) Any type of lime used alone is of little value as a reclamation agent.

(4) Phosphates are a more potent reclamation agent than lime, and phosphates without lime are much more effective than lime without phosphates.

(5) Lime and phosphates used together are more effective than either used alone.

(6) The commercial grades of basic slag, mineral phosphate and superphosphate are the types of phosphatic manure likely to be of greatest economic value in reclamation.

(7) Very low-grade basic slag and the "Peerless" phosphates, if these were available commercially, would be even more effective.

(8) The molecular composition of the phosphates is probably very important.

(9) There have been no visible results from the use of potash and quick-acting nitrogen.

(10) Dung is the most potent of all manures for reclaiming moss.

(11) It may be possible to dung moss gradually by grazing with stock introduced at intervals from fertile land.

(12) It is possible to improve the herbage, without cultivation of any kind, by sowing grass and clover seeds on the surface.

(13) The seeds germinate and establish themselves best where dung has been applied.

(14) Where no dung is applied one or two years must elapse after the lime and manures are applied before the moss develops a condition favourable for surface seeding.

(15) Some types of phosphate, "Peerless" for example, appear to be more favourable for germination than others.

(16) The natural herbage must not be allowed to overshadow the introduced herbage.

(17) Tramping by stock, or anything that will consolidate the surface moss, greatly assists in establishing the grasses and clovers sown.

It must be borne in mind that these are simply the impressions of one person who has made a careful and continuous study of the area since it was first selected for drainage in 1920. Unsupported by figures these impressions may lose some of their value, but nothing has been written without very careful examination and equally careful consideration, and in work of this kind the evidence of the senses may be nearly as valuable as data accumulated by more scientific or more accurate methods.

Afforestation Area.

Seedling Scots Pine, Birch, &c., are fairly common on the moss, but they are generally destroyed by fire before they can attain any considerable size. It is quite noticeable that

seedling trees, especially birch, appear to spring up most readily on the ground where sea birds nest freely and where the moss has been liberally manured with their dung. A small area at the north end of the reclamation area was planted in March 1926. Young trees of the four varieties, Scots Pine, Mountain Pine, Sitka Spruce and Norway Spruce, were supplied by the Forestry Commission and an experienced member of their staff was sent to superintend the planting. Previous to planting the area was drained by open drains cut at 18 feet centres.

During the early summer of 1926 the Scots Pine, Sitka Spruce and Norway Spruce made considerable growth, but later the rate of growth became much slower, and during the whole of 1927 not much progress was made. The Mountain Pine seedlings supplied were one year younger than those of the other three varieties, and naturally this species has made relatively less progress. All the species stood the winters of 1926-27 and 1927-28 very well, the death-rate being low. It is too early yet to assess the effect of the intense frost experienced during February 1929.

Five rows of trees were planted between each two open drains and the treatment was as follows :—

First row. Basic slag 32 per cent.
Second row. No treatment.
Third row. Basic slag and 30 per cent. potash salts.
Fourth row. No treatment.
Fifth row. Limestone.

Up to the present it is possible that the better drainage secured by the rows next the drains has been more effective than the treatment given. All that can be said meantime is that the whole area has made exceedingly good progress.

AN INTERESTING CO-OPERATIVE EGG-COLLECTING STATION.

A. G. Ruston, D.Sc., B.Sc.,

University of Leeds.

At the present time, when the question of marketing is looming large on the agricultural horizon, and a definite scheme for the improved marketing of eggs has been launched with every prospect of success, a survey of the working of one of the pioneers in this direction is of interest.

The Stamford and District Co-operative Egg and Poultry Society, Limited, though fairly small has had a quite successful history, and has undoubtedly played a useful and valuable part in helping to develop the poultry industry in the district. Formed in September 1916, as a result of the work entailed in the collection of eggs for military hospitals, the Society has throughout

been well managed, run on sound and economic lines, and although it has not expanded rapidly has built on sure foundations, and progress, particularly of late, has been steady and well maintained.

During the twelve years of its existence, after paying its members for their eggs prices above rather than below those prevailing in the district, it has set aside £1,124 to meet the depreciation of its plant, and after making allowances for this has shown a total trading profit of £2,371, of which £940 has been kept in the business as reserve, £243 has been utilised in paying interest on subscribed capital, and £1,188 has been distributed as bonus to members and staff.

We know no other British Farmers' Co-operative venture which publishes such full and comprehensive details in its annual report, balance sheet and trading account. The study of those accounts supplies much useful information to those who contemplate becoming "accredited packers" under the improved Egg Marketing Scheme.

Under the approved scheme an accredited packer must :—

(*a*) handle 30 cases a week during seven months of the year; not less than 20 cases a week during August and September; not less than 10 cases a week during October, November or December; [1] the equivalent of approximately half a million eggs a year. The Stamford Egg Collecting Society are handling nearly two million eggs a year;

(*b*) candle his eggs *singly* within 48-hours of despatch. At Stamford the eggs are tested and candled, and when the station was last visited they were being candled individually and not in bulk after the Danish method;

(*c*) grade his eggs in standard grades for size and quality. At Stamford grading has been in vogue for some time, though the grades hitherto adopted have not necessarily been synonymous with those now officially suggested under the scheme;

(*d*) pack his eggs in new and non-returnable packages. At Stamford the system of collection and delivery of eggs allows of the same cases being used over and over again.

It will thus be seen that while the Stamford Egg Collecting Station has been working along the lines of the approved scheme, yet as far as organisation and methods of procedure are concerned there are essential points of difference. The Stamford figures, therefore, though exceedingly valuable, must not be

[1] These figures refer to the English scheme.
The corresponding figures for the Scottish scheme are :—

Mainland.—Jan.-Sept., 180 doz. per week; Oct.-Dec., 90 doz. per week.

Orkney, Shetland and Western Islands.—Jan.-Sept., 120 doz. per week; Oct.-Dec., 60 doz. per week.

taken as an infallible guide to any individual or organisation who may wish to carry out the approved scheme in its entirety.

Amount of Capital Required.—A study of the published balance sheets shows that at the end of the first year the Society was being run on a working capital of only £355, and that at the end of twelve years' working, when nearly two million eggs a year were being handled, the total liabilities were little more than £1,600. Over a series of years the total working capital—subscribed, accumulated or borrowed—required to finance the business has averaged throughout the period roughly *two pence per dozen eggs handled*, a figure which compares very favourably with those we have found to obtain in the case of similar organisations in this country and in Denmark.

Other Co-operative Egg-Collecting Stations.	*Capital required per dozen eggs handled.*
	pence.
British Society A	5
Do. B	3¼
Do. C	3¾
Danish Society D	3¾
Do. E	2
Do. F	2¾
Do. G	1½

The policy of the Society throughout has been to finance itself from within, the owned capital being partly subscribed and partly in the form of accumulated profits left in the business as reserve, averaging throughout the twelve years of its existence 94 per cent. of the total.

It is interesting to find that while the average amount of share capital has in no year exceeded 30*s*. and is to-day standing at only 18*s*. 9*d*. per member, the Society should have been able to work without having recourse to any heavy bank overdraft or other outside loan, and at the same time pay what is practically spot cash for the eggs produced. The average period of credit received has been less than three days, and this was due to the fact that a few of the larger producers prefer monthly payments instead of the cash on delivery method.

Investment of Capital.—If we look at the credit side of the published balance sheets, we find that the assets may be conveniently classed under five heads.

The first point worthy of mention is the comparatively large amount retained in the shape of cash and liquid assets from year to year. The poor trading years of 1921 and 1922 undoubtedly seriously affected this, but by 1925 the Society had so far recovered that this item, amounting to £669, of which the greater part was in the bank, represented more than 63 per cent. of the total assets. Upon this large bank balance the Society has been able to draw for cash payments to its members for the eggs supplied by them.

Had the Society been wound up in September 1927 each

member, having originally subscribed on the average 18*s*. 9*d*., after already receiving 5 per cent. interest on his investment and 30*s*. as bonus, would have found an additional 51*s*. 6d waiting to be distributed to him as his share of the proceeds.

Again it will be seen that the debts due to the Society for produce sold amounted only to £221, and represented 16 per cent. of the total assets. Moreover, as in the case of its purchases so with its sales, the basis of trading may be said to be strictly cash, the average amount of credit given to purchasers of eggs being only from seven to eight days.

This inter-relationship between credit given and credit received is an important factor in the financing of any business, whether co-operative or otherwise. In co-operative societies whose accounts we have had an opportunity of studying its influence can be traced both in Requisite and Produce Societies.

The Stamford Egg Collecting Station handles approximately the same number of eggs as does the British Society A referred to on page 146. Both pay their members practically spot cash for the eggs purchased from them. Stamford gets a settlement once a week for the disposal of their eggs with the merchants to whom they are sold; the other Society once a month, with the result that the former Society has to have available cash to meet the working expenses of only one week and the latter of four weeks.

It is not without significance that in the former case the called up capital is 18*s*. 9*d*. per member or 2*d*. per dozen eggs handled, and in the other £3, 1*s*. 5*d*. per member or 5*d*. per doz. eggs, and yet the former is working with a bank balance of approximately £900 and the other with a bank overdraft of more than £700.

In the case of two Co-operative Requisite Societies: one over a series of 21 years has paid cash within a fortnight for the goods it has purchased, thus taking advantage of all the available trade discounts, and has passed on that fortnight's credit at no cost to itself, practically *en bloc* but *in no excess* to its members. This Society has made money consistently, and the members have been able to benefit directly by the money made. During this period the total profit amounted to over £50,000, of which approximately—

£21,000 has been paid to the members in the form of bonuses;

£23,000 has been made over to them in the form of bonus and dividend bearing shares; while

£8,211 has been left in the business in the way of reserves.

The other Society receives 6½ *weeks' credit from the Trade*, thus losing practically the whole of the trade discount; but it has been allowing three months' credit to its members, with the result that, in spite of the fact that well over £6,000 net profit has been made by the Society, not one penny of this sum has found its way directly into the pockets of the members in the

form of bonus or dividend, the whole of the accumulated profits having to be left in the business in order to finance it.

On examination of the question of stock-in-hand, it will be seen that with the exception of the two years ended 6th September 1920 and 1921, the Stamford Society has been carrying very little stock, the eggs purchased being passed on and disposed of quickly; the items under this heading in the years mentioned represent mainly corn and poultry food, of which they found themselves saddled with heavy stocks on a falling market. The lack of foresight shown in this respect is one of the few points on which it would be possible adversely to criticise the management.

In the case of its motor vehicles, the Society has consistently carried out the policy of writing down their value heavily each year. Two motors—a light van and a one-ton lorry—are used for collection and delivery. They were purchased at a time when prices were high, one in 1918 and the other in 1920, and by 1926, after which one was replaced, they were standing in the books at what can be regarded as scrap value only.

The Society possesses no extravagant buildings or equipment; the business premises, really an old house, though very convenient as regards accommodation, are rented at £25 a year. It has no cold storage plant nor tank suitable for pickling, though in the flush season eggs are sent to Chelmsford for preservation under the new gas treatment. Should it be necessary for the Society to use non-returnable packages for the despatch of their eggs now that they are officially recognised as "accredited packers" under the approved scheme, it is likely that the capital outlay for additional equipment will be to some extent increased. During the last twelve years the amount invested in equipment and dead-stock other than motor transport has represented only 7 per cent. of the total assets.

Although a study of the Society's balance sheets may yield much that is of interest regarding what may be termed its "statics," yet fuller and possibly more useful and interesting information should be obtained from an examination of its "dynamics" as revealed in the trading accounts.

In an ordinary trading concern the policy of the management is, briefly, to buy in the cheapest market and sell in the dearest, keep down the working costs and overhead charges as far as possible compatible with efficiency, and push the sales. The end and aim of all joint stock enterprise is "surplus and net return on capital investment."

The success of a Co-operative Producers' Society cannot be gauged by the same standard. In the case of a Co-operative Egg Collecting Station, the final aim of the management is, or should be, not to show a high profit on the trading account, but to be able to pay to its members either in the form of initial or final and possibly bonus payment as high a price as possible for the eggs which have been produced. The same principle holds good

in the case of a co-operative creamery, bacon factory, abattoir or wool collecting station.

In any co-operative venture any profit or surplus made by the Society in its trading should finally find its way directly or indirectly back to the members, and such surplus, after all other legitimate calls have been met, may be looked upon as, to a certain extent, supplementing the price originally paid by the Society to its members for the commodities supplied to them. The price finally payable to the members will actually be the *price realised* less the *cost of handling*.

Salesmanship.—Unless the eggs or other commodities are sold well it will be impossible for the management to pay a good price to their members, however efficiently and economically the eggs may have been handled. Hence, in a Society of this description *the main essential of success is good salesmanship, and the* information obtained from a study of the trading account should prove a useful index as to the efficiency of the management under this head.

The average prices obtained from the sale of eggs, though reasonable, have not been abnormally high, a point which is borne out by a comparison of the average price obtained for the eggs sold through this and other societies in any given year.

Thus in 1924 when all the eggs handled by the Stamford Society were being sold at an average of 1*s*. 9¼*d*. per dozen, and imported Danish eggs were coming in at an average of 1*s*. 10*d*. per dozen, the three other British Egg Collecting Societies already mentioned disposed of their eggs at average prices :—

A of 1/8¼*d*. per doz.
B of 1/5*d*. per doz.
C of 1/10¼*d*. per doz.

If a high average price is to be obtained throughout the year, both members and management must play their part. The management can scarcely be expected to obtain high prices for the eggs supplied by the members if too large a proportion is sent to the Collecting Station in the spring when eggs are cheap, and too few in the autumn when they are dear. No system of poultry management can make birds lay as heavily in the winter months as in the spring and early summer, but by judicious selection of time of incubation and careful nursing and feeding of the laying birds it is possible to do much to increase winter egg production, and to smooth out the seasonal variation in the egg supply.

In the matter of maintaining a regularity of supply the management is not altogether without responsibility. Winter egg production is no more a strong point in Denmark than in England, but the Dane has learnt that the art of good salesmanship does not lie in flooding an already overcrowded market. When production is high, as in this country in the spring, an enormous amount of eggs are " put down " in the pickling tanks to come out again in the autumn; a policy which is being adopted

with success by the Co-operative Egg Collecting Station at Framlingham. During the present summer we had an opportunity of going over the largest packing station in the North of Ireland; and surplus eggs there are cold stored in the spring, and this practice is also followed to a large extent at Preston. Until quite recently the whole of the eggs received at Stamford during the period of flush were immediately put upon the market, however much it was depressed.

Again, really good salesmanship results in *repeat orders*, and sound financial success depends upon regular rather than on casual customers. It is essential, therefore, to study customers' needs and to ensure that the goods supplied will prove satisfactory. In the case of eggs it entails standardisation and grading and a supply which must be reliable, clean, fresh and uniform in size.

The success of the Dane in capturing our egg, butter and bacon trade has been built up on a study of the British market, and on the supply of a good article of uniform standard which meets the demands of the British public.

In order to achieve this object members and management must both play their part. The members must take care to send in clean, fresh and reliable eggs, and the management must take every precaution to see that the eggs are tested, graded and guaranteed, and packed in cases which are convenient to handle. The published records of the Society show that in this respect the members are coming to realise their responsibility more fully.

Year ended 6th Sept.	*Total bad eggs.*	*Bad eggs sent in per* 1000.
1925	3,666	2·37
1926	3,603	2·11
1927	3,057	1·75
1928	3,044	1·64

While, however, the members by their united action can do much, the really all-important factor of success is the *business ability, organising power and salesmanship of the management*, and it is in this respect that so many of the agricultural co-operative ventures in this country have failed, and in which the Stamford and District Co-operative Egg and Poultry Society has been so singularly fortunate.

The policy followed from the start has been to sell direct to the retail shops, while of recent years an ever increasing retail trade from the Society's own premises has been built up until now such sales amount to anything from £50 to £70 per week.

Cost of Handling.—It has already been pointed out that in the case of a co-operative venture of this description where all profits finally find their way back to the members, the price which the Society will be able to pay for the eggs supplied by them will be *the price realised by their sales less the cost of handling*.

If, therefore, the Society is to justify its existence, and the members are to receive a satisfactory price for their eggs, good salesmanship must be supplemented by economy in management and low working costs. While improvements might be, and actually are being, made, as far as salesmanship is concerned, it would be difficult to speak of the "handling costs" other than in terms of the highest appreciation, and one doubts whether it would be possible in any way to reduce these and at the same time maintain the economic efficiency which has all through been so marked a feature in the management of the Stamford Egg Collecting Station.

Working Costs per dozen Eggs.

Year ended 6th September.	Transport.	Wages.	Other Charges.	TOTAL.
	pence.	pence.	pence.	pence.
1921	1·67	1·25	0·55	3·47
1922	1·54	1·26	0·52	3·32
1923	1·16	1 04	0·42	2·62
1924	0·92	0·96	0·32	2·20
1925	0·86	0·92	0·31	2·09
1926	0·92	0·96	0·27	2·15
1927	0 55	0 93	0·30	1·78
1928	0·39	0·99	0·28	1 66

It is interesting to find that during the twelve years of the Society's existence the total amount paid in salaries has agreed very closely with the total transport costs, the former amounting to £5,337 and the latter to £5,010. It is still more interesting to find that while of recent years the transport costs have tended to fall, salaries have risen. Apparently the management committee are realising that the growing success of the Society is due in no small degree to the hard work, devotion, and business ability of its staff.

With expanding sales and transport re-organisation, the working costs at Stamford have of recent years been reduced considerably to the pecuniary advantage of the members.

On the other hand it is important to realise that should either the confidence or loyalty of the members be lost, and that loss of confidence be reflected in falling trade, difficulties are bound to be experienced in curtailing expenditure in proportion to the reduction in the turnover.

Direct working costs may be adjusted more or less in proportion to the trade, but with overhead charges such adjustments are much more difficult. This point is well illustrated in the case of the British Society A, whose sales have since 1922 been steadily falling. In 1922 they were handling approximately two and a half million eggs, in 1926 less than a million and a quarter. In spite of drastic reductions in total expenditure, unit costs of handling have with a falling turnover been steadily rising, until in 1926 they stood at well over 5*d*. per dozen, and the practical utility of this Society had really ceased to exist.

Price paid to the Producers.—It has already been pointed out that the price which is finally *payable* to the members will be the *price realised* less the *cost of handling*. It does not, however, necessarily follow that the price payable is the price actually paid.

Per dozen Eggs.

Year ended 6th September.	Average selling price.		Cost of handling	Average Price.			
				Price payable to members.		Price actually paid to members.	
	s.	*d.*	*d.*	*s.*	*d.*	*s.*	*d.*
1921	2	10½	3½	2	7	2	8½
1922	2	2½	3¼	1	11¼	2	1
1923	1	10	2½	1	7½	1	6¾
1924	1	9¼	2¼	1	7	1	6¼
1925 .. .	1	9¼	2	1	7¼	1	6½
1926	1	8½	2	1	6½	1	5¼
1927	1	7½	1¾	1	5¾	1	4¾
1928	1	7¼	1½	1	5¾	1	4½

From 1917 to 1920, in the days of high and rising prices, the price actually paid was less than the price *payable*, with the result that the accounts showed each year a profit, the greater part of which was left in the business in the form of reserve. For the next two years, after the peak had been reached and prices were falling rapidly, the price actually paid to the members was greater than the price payable, with the result that during this period the accounts showed a loss, which was met by drawing on the previously accumulated reserve. From 1923 onwards the management have reverted to their original policy, with the result that the accounts have again consistently shown a trading profit and the reserve fund has been steadily growing.

To producers in industrial areas where prices are high and markets are good these average prices paid by the Society to its members may not seem any too satisfactory, but they are undoubtedly higher than they would have been in the Stamford area had the Society failed to function.

Profit or Loss.—While the main aim of a Co-operative venture of this description should be to obtain remunerative prices for their members rather than large profits, yet it is obvious that in all its transactions it must work with an eye to the trading account and balance sheet, and it is desirable that the annual accounts should show a balance on the right side. For this it is essential that the gross margins must be left sufficiently wide to cover the overhead charges and working costs. This has happened in 10 years out of 12, and the net profits so obtained, though not large in total money value, have throughout been high in terms of the subscribed capital, the owned capital, or total liabilities, but not necessarily high in proportion to the turnover.

The financial success of this enterprise has been in no small measure due to the fact that the capital invested in the business has been kept turning over rapidly, in contradistinction to what

usually happens on the ordinary farm, where little more than 80 per cent. of the total working capital is turned over each year.

The total profit obtained by any trading concern will be influenced mainly by three factors :—(*a*) the gross margin; (*b*) the working costs; (*c*) the turnover.

If we buy in the cheapest and sell in the dearest market the gross margin should be high. The management at Stamford prefers to pay to its members as high a price as it possibly can for the eggs which they have produced, and is working on a margin of from 2*s*. to 2*s*. 6*d*. per great hundred, which other societies might consider narrow.

When working with a comparatively narrow gross margin of 16 per cent., low working costs are essential if a net margin on the right side is to be obtained. It is undoubtedly in this direction mainly that the Society has scored, for the working costs throughout have averaged only 13½ per cent. of the purchase price, leaving a net margin of 2½ per cent. on the right side. With a low capital turnover, a net return of 2½ per cent. on the purchase price would leave a low return upon the capital invested, but when during the year the total capital owned and unowned is turned over roughly twenty times the original modest 2½ per cent. mounts to 25 per cent.

Stamford.

Year ended 8th Sept.	Gross Margin.	Working Costs.	PROFIT	LOSS	PROFIT OR LOSS IN TERMS OF—			
					Subscribed Capital.	Owned Capital	Total Liabilities	Turnover.
	£	£	£	£	per cent.	per cent.	per cent	per cent.
1917	430	225	205	...	154	58·5	57·7	5 5
1918	1,060	572	488	...	174	52·0	49·0	5 3
1919	1,040	877	163	...	46	14·2	13 0	1·3
1920	1,431	1,370	60	..	15·5	5·0	4·7	0 4
1921	1,521	1,616		– 95	–21·5	– 8·5	– 7·0	6·6
1922	1,229	1,351	. .	–122	- 26 5	–17·0	-15 5	- 1·2
1923	1,342	1,258	84	...	18·0	10·7	10 0	0 9
1924	1,464	1,297	165	.	35·0	19·0	17·5	1·6
1925	1,499	1,218	280	...	58·0	28·0	26·5	2·4
1926	1,615	1,318	297		63·0	26 0	21·0	2 5
1927	1,578	1,202	376	...	81·0	27·0	26·8	3 1
1928	1,612	1,062	550	..	118·0	34·6	33·0	4·4

Conclusions.—1. An Egg Collecting Station, handling approximately two million eggs a year, can be run successfully with a working capital of approximately £1,500, the equivalent of 2*d*. per dozen eggs handled each year.

2. In a Society of this description the main essential of success is good salesmanship.

3. Really good salesmanship is possible only when members and management both realise and act up to their responsibilities.

4. Under good organisation it should be possible to keep the working costs within the limits of from 1½*d*. to 2*d*. per dozen eggs.

5. It is wise in the early stage of such a Society to consolidate the financial position and build up a reserve fund.

I should like to tender my thanks to the manager and directorate of the Stamford and District Egg and Poultry Society for placing their records absolutely at my disposal, and to express my indebtedness to my two late colleagues, Mr. O. Anderson, M.Sc., and Mr. C. V. Dawe, M.Com., for invaluable assistance in working up the statistical data available in the case of this and similar societies in this country and in Denmark.

SPECIAL AGRICULTURAL INDUSTRIES OF CANADA—I.

ERNEST H. GODFREY, F.S.S.

As a rule, when reference is made to Canadian agriculture, it is the grain crops of the Dominion, and especially wheat, that chiefly arrest attention. In Canada the usual grain, root and fodder crops of the temperate zone flourish in each of the nine provinces, and their annual value averages about £230,000,000. But, in addition, there are special agricultural industries peculiar to specific localities, which in the aggregate represent an important contribution to the national revenue. Some of them received incidental mention in a previous article by the present writer six years ago.[1] It is now proposed to describe more fully the origin, development and present position of seven of these industries: (1) Dairying; (2) Fur Farming; (3) Fruit Growing; (4) Maple Syrup and Sugar Extraction; (5) Sugar Beet Cultivation; (6) Tobacco Growing; and (7) Floriculture. In all of these industries the foundations were laid and ultimate success was achieved largely by the enterprise and energy of Scotsmen.

Dairying.—Dairying is one of the oldest industries of Canada, and within comparatively recent times it has become one of the most important. The first permanent introduction of cows into Canada was made by Champlain at Quebec about the year 1608. In 1629 he possessed 60 or 70 head of cattle at Cap Tourmente. In 1660 the French Minister Colbert sent some of the best dairy cows of Normandy and Brittany to New France. In 1667 early censuses showed that there were 3,107 head of cattle in New France, and in 1671 there were 866 in Acadia. The first cattle in what is now called Ontario were taken thither by La Motte Cardillac in 1701. In 1823 a herd of 300 cattle was driven north to the Red River Settlement, now known as the province of Manitoba. Cattle in British Columbia date from 1837.

Modern dairying in Canada owes its development to the factory system for the making of cheese and butter, to the introduction from Denmark in 1882 of the mechanical cream

[1] The Agricultural Production of Canada, April 1922, p. 170.

separator, and to the facilities afforded by improved methods of cold storage organised by the Dominion Department of Agriculture from the year 1895. In 1891 the adoption by the United States Congress of the McKinley Tariff closed the American market to eastern-grown grain, with the consequence that the farmers of Ontario and Quebec turned to dairying, and by Government aid eventually established an important export trade to Great Britain of cheese, and of butter also, but to a less and fluctuating extent.

The first modern cheese factory in Canada was established in Oxford Co., Ontario, in 1864. Shortly afterwards, factories were set up in other eastern provinces. After 1870 the number increased rapidly. In 1868 the quantity of cheese exported from Canada was 6,141,570 lb. In 1904 the maximum quantity of 233,980,716 lb. was exported. The present annual exportation varies from about 1,200,000 lb. to 1,500,000 lb. The total production of factory cheese in 1927 was 138,026,861 lb. of the value of £5,250,000 as compared with 171,731,631 lb. of the value of £5,927,500 in 1926.

Within the last four years a special form of prepared cheese has been made by the factories and is known as "processed cheese." It is made from ordinary Cheddar cheese, and the process consists essentially of grinding the cheese, heating it in a jacketed container with agitation, and filling it into the proper containers, either directly or with specially designed machinery. The cheese is pasteurised by the heat applied, and the effect is to check fermentation. A secret of the process is to apply this degree of heat and at the same time prevent the fat from "oiling off." In 1927 the production of processed cheese was 15,386,617 lb., as compared with 20,298,428 in 1926 and 32,652,569 lb. in 1925. The export of this cheese during the calendar year 1927 amounted to 3,725,244 lb., as against 10,872,755 lb. in 1926 and 21,381,523 lb. in 1925.

The first creamery for the co-operative manufacture of butter was established in the province of Quebec in 1873, and the first cream separator was installed in 1882. In Ontario the first creamery was established in 1875, and the first cream separator in 1883. Butter reached its maximum exportation for the year ended June 30, 1903, with 34,128,944 lb. The present exportation is about 24,000,000 lb. For 1927 the total production of creamery butter was 178,438,013 lb. of the value of £13,595,000. Within the last ten years there has been a large increase in the manufacture of condensed milk and other dairying bye-products, including evaporated milk, milk powder, whey butter, casein, ice cream, &c. The first milk-condensing plant was erected at Truro, Nova Scotia, in 1883; and there are now in Canada 24 plants for the manufacture of condensed and evaporated milk and milk powder. The quantity of condensed milk now made annually is about 30 million lb. and of evaporated milk about 45 million lb.

Produce of cheese factories and butter creameries does not,

however, represent the total dairying output of the Dominion. Quite a large proportion of butter is made on individual farms, and is distinguished by the name of "dairy butter." There is also a small production of home-made cheese. The annual production of dairy butter is estimated to be about 100 million lb. and of home-made cheese about half a million lb.

Hitherto the dairying industry of Canada has been chiefly confined to the east, and notably to the two large provinces of Quebec and Ontario. But latterly the dairying industry has been spreading into the western prairie provinces, from which surplus dairying products are now being annually exported. This development means a considerable advantage to prairie farming, since it lessens the risk of entire dependence upon grain-growing, maintains soil-fertility by the raising of live stock, and provides all-year employment of profitable character.

For 1927 the total estimated value of the dairy products of Canada was £50,513,000, distributed by provinces as follows: Prince Edward Island, £712,000; Nova Scotia, £2,395,000; New Brunswick, £1,656,000; Quebec, £15,432,000; Ontario, £21,947,000; Manitoba, £1,930,000; Saskatchewan, £2,841,000; Alberta, £2,401,000; British Columbia, £1,199,000.

Fur Farming.—The fur trade is almost the oldest of Canadian industries; for it was largely the trapping of fur-bearing animals that led to the establishment of the Hudson's Bay Company and the exploration of the great North-West. Since the early days of this trade it has been the practice for trappers to keep foxes caught in warm weather alive until the fur was prime, and from this custom has arisen the modern industry of fur-farming. The earliest authentic record of the raising of foxes in captivity comes from Prince Edward Island, where nearly 50 years ago a number of foxes were raised on a farm near Tignish. The great beauty of the fur of the silver fox, and the high prices realised for its pelts, caused special attention to be directed to this breed—a colour phase of the common red fox—and eventually the silver fox breed was permanently established through selective breeding carried on by pioneer fox farmers.

After the year 1890 came a period of rising prices for furs, and the fox-farming industry grew rapidly in Prince Edward Island. In 1913 a provincial census showed 277 fox farms with a total of 3,130 foxes. This new industry came as a very valuable adjunct to ordinary farming, for as most of the farmers in the Island possessed a certain amount of woodland, it was easy to wire off separate enclosures and keep the breeding foxes under ideal conditions. So remunerative is the industry that many of the farmers derive more profit from their small fox ranch than from the whole of the rest of the farm. While the early experiments were being carried on in Prince Edward Island, attempts at raising foxes in captivity were also being made in other provinces; and foxes were bred successfully in Quebec in 1898, in Ontario in 1905, and in Nova Scotia in 1906. In 1912 and 1913 the Canadian Commission of Conservation con-

ducted an exhaustive inquiry into the history and possibilities of fur farming in Canada, and their report published in 1913 gave a considerable impetus to the industry. Soon pedigree books of record were instituted: in 1915 by the Prince Edward Island Silver Fox Breeders' Association, and in 1920 by the Canadian Silver Fox Breeders' Association. Fox farming is now carried on in all the provinces of the Dominion, and the number of farms is steadily increasing. In 1925 an experimental fox ranch of five acres was established by the Dominion Government at Summerside, P.E.I., where the fox farmers' problems of breeding, feeding, housing and general management are being systematically studied. Although the fox has proved most suited to domestication, other species of wild fur-bearing animals are being raised in captivity, including the mink, raccoon, skunk, marten, fisher and rabbit. Karakul sheep, from which are obtained the furs known as Persian lamb, Astrachan and Broadtail, are also being raised successfully. Mink farms are the most numerous of this miscellaneous class, raccoon farms coming next. A few of the fox farms raise other fur-bearing animals as well.

At present there are in Canada about 2,500 fur farms, and the number of silver foxes exceeds 55,000, about 43,000 being in Prince Edward Island. The total revenue from the sale of live animals and pelts amounts to about £800,000 per annum, and the total value of the animals on the farms to over £2,000,000.

These figures represent only a small proportion of the total fur production of Canada. A recent report of the Canadian Bureau of Statistics shows that for the twelve months ended June 30, 1927, the total value of the raw fur production of Canada, including pelts of fur-bearing animals taken by trappers and also of those raised on fur farms, was £3,669,500, as compared with £3,101,300 in the season 1925-26, the increase being principally due to an advance in the price of pelts.

Fruit Growing.—Wild fruits in Canada are numerous and varied, and all kinds of fruit may be successfully grown in all but the colder parts. Fruit growing as a commercial industry is, however, limited to certain well-defined districts, including the Annapolis Valley of Nova Scotia, the southern half of Ontario and the valleys of British Columbia. In the valley of the St. John River, New Brunswick, and also in certain counties of Quebec, apple growing on a commercial scale is successfully practised.

In Nova Scotia the apple growing industry has assumed great importance; the bulk of the crop is annually exported to Great Britain. There are records of the growth of apples in Acadia from 1635. In 1698 there were at Port Royal 1,584 apple trees belonging to 54 families, of whom many possessed orchards of from 75 to 100 trees. At Beaubassin there were in the same year 32 acres in fruit trees. The first apples to be exported from Nova Scotia went by sailing vessel from Halifax to Liverpool in 1849, the price then realised being \$2 (8*s*. 4*d*.) per barrel. In 1856 700 barrels were sent by schooner to Boston, U.S., and

realised \$2·75 (11*s*. 4*d*.) per barrel. Experimental shipments to England in 1861 proved disappointing, but a shipment by the steamer "Neptune" from Annapolis Royal to London in 1881 was fairly successful. The consignment consisted of 6,800 barrels, and the voyage occupied fourteen days. From this date the trade has continued to expand. Up to 1890 the annual production of Nova Scotia apples rarely exceeded 100,000 barrels, but after this date the acreage and production increased, and in 1909 the yield reached one million barrels. A record crop of about 1,900,000 barrels was produced in 1911, when 1,734,876 barrels were exported. Further records were made in 1919 with over two million barrels, and in 1922, when 1,891,850 barrels were packed and sold from the Annapolis and adjacent valleys. The apple growing districts of Nova Scotia comprise an area about 100 miles in length and from six to eleven miles in width. Records of the production of apples in Quebec date from 1663, and the celebrated "Fameuse" apple is said to have originated in this province. The capabilities of the successful growth of apples in Quebec are great, but at present not sufficient are grown to satisfy the local demand, and large quantities are imported from the other provinces.

It is in Ontario that the commercial production of all kinds of fruit has reached the highest development. Here apples have been grown from the middle of the eighteenth century. Commercial orcharding has, however, been practised only within the past 50 or 60 years. It became possible when railway construction allowed of the rapid transportation of trees and fruit.

The greater winter apple districts include the border of Lake Ontario, extending back 30 miles or more from the Lake, the shores of Lake Huron and Georgian Bay, and the south-western part of the province. Further east and north, and including an area east of Lake Huron, there are large districts where the hardier varieties of apples are suitable. In the Niagara fruit growing district, besides apples, peaches, pears, plums and cherries, small fruits and grapes are produced on a large scale.

The remaining fruit districts are in British Columbia, where commercial production has had a very rapid development, especially during the last twelve years. The first apple trees were planted about the year 1850, but not till after the completion of the Canadian Pacific Railway in 1886 were many trees planted for commercial purposes. Progress is shown by the fact that the fruit acreage of the province has grown from 6,500 in 1891 to 43,569 in 1921. The most noted fruit district in the province is that of the Okanagan Valley, where now exist some of the finest orchards in Canada. Boxed apples from British Columbia are sent to all the important markets of Great Britain and Europe. Pears, plums, peaches, apricots, cherries and small fruits are also grown in this province on a large scale.

Much has been and is being done to encourage fruit growing by the Fruit Branch of the Dominion Department of Agriculture. The Branch issues telegraphic information concerning the fruit

markets, reports on the condition of the growing crops, and publishes a great variety of information useful to fruit growers. A Fruit Marks Act passed in 1901 made compulsory the grading of commercial apples. In 1923 the Fruit Act replaced previous legislation. It provides for Government inspection, imposes penalties for dishonest packing, and defines the grades under which different descriptions of fruit shall be sold.

In 1927 the total production of commercial apples in Canada was estimated at 2,810,000 barrels, of the value of £2,082,207, compared with 2,954,370 barrels, value £1,937,632, in 1926. The average value per barrel in 1927 was 15*s*., as compared with 13*s*. in 1926. The value of the total commercial fruit production of Canada in 1927 was £3,521,199, as compared with £3,044,914 in 1926.

Recently the Dominion Government has published annual statistics of the numbers sold of nursery stocks of each of the different varieties of fruit trees, bushes and plants, one object being to discover the varieties most useful and popular. The latest figures show that for the year ended May 31, 1927, the sales amounted in value to £63,534.

The value of the total exports of Canadian fruits was £1,263,043 for the year ended March 31, 1927, as compared with £1,677,100 in 1925-26. Apples are the largest item, representing about 73 per cent. of the total in both years.

Maple Syrup and Sugar Extraction.—Tapping of maple trees for the manufacture of maple syrup and sugar is an industry peculiar to the North American Continent. It had a very early beginning, as before the advent of the white man the Indians had learned to extract and concentrate the sap of the maple tree. On the approach of spring the trees were gashed with the tomahawk in a slanting direction, and beneath the opening was inserted a wooden chip or spout to direct the fluid drop by drop into a receptacle on the ground. The sap was caught in a birch bark dish and boiled in earthen kettles. The small quantity of dark, thick syrup thus made was the only sugar available to the Indians and was highly prized. The first white settlers learned from the Indians the art of maple sugar making, and for about a century followed their crude methods, except for the substitution of iron or copper kettles for vessels of clay and bark. But during the past 50 years the manufacture of maple sugar has become a highly organised commercial industry, and metal is now almost entirely used for every article with which the sap-sugar comes into contact. In the well-equipped modern plant the sap flows from the collecting tank to the storage vat, thence to the evaporator, and when boiled to the proper consistency into the receiving can. Where conditions permit, pipe lines conduct the sap from outlying collecting centres to the camps where evaporation takes place.

For the whole of Canada the estimated production of maple sugar in 1928 was 13,798,109 lb. of the value of £467,000, the average wholesale price per lb. being 16 cents, or 8*d*. The

estimated production of maple syrup was 1,686,583 gallons of the value of £682,078, an average per gallon of 7*s*. 8*d*. The total value of sugar and syrup produced in 1928 was £1,149,000.

Maple sugar and syrup are produced on a commercial scale in the provinces of Nova Scotia, New Brunswick, Quebec and Ontario; but by far the largest producer is the province of Quebec, in which for 1928 the value represented 64 per cent. of the whole.

INSECT PESTS.—No. IV.

R. STEWART MACDOUGALL, M.A., D.Sc.

ACARINA INJURIOUS TO STOCK.

IN the October number of the *Scottish Journal of Agriculture* we completed our review of the true insect enemies of stock and then proceeded to give some account of the Acarina or Mites, not really insects but belonging to the neighbouring class of jointed-footed animals, the *Arachnids*. A description was given of the *Sarcoptidæ* or Mange Mites, and we conclude this section of the subject by taking in turn the other Acarine families that are enemies of the stock-owner, including enemies of poultry.

The Hair Follicle Mites or *Demodecidæ*.—The mites of this family are extremely minute forms found in the hair-follicles and sebaceous glands of man and a number of other mammals. The best known to the veterinarian is the species infesting the dog, the disease of the skin due to its presence being known as follicular or demodectic mange. Demodex mites, instead of having the rounded or oval form characteristic of most mites have an elongated body. Under the microscope a head-thorax region can be distinguished followed by an abdomen which is transversely striated above and below, and is rounded at the end (Fig. 1). The mouth-parts (mandibles and maxillæ) are needle-like, with the two palps closely pressed against the under side. There are eight legs of five joints each in the adult. From the egg hatches a larva which may be legless as in the Demodex of the ox, or may show three pairs of rudimentary legs or tubercles; a moult takes place resulting in a nymph with eight rudimentary legs; another moult results in a second nymph stage with the mouth-parts better developed and the legs jointed; the second nymph moults and yields the sexual adult. The males are rather smaller than the females, with the abdomen more poorly developed. *Demodex folliculorum* has been recorded from man, and varieties of the Demodex from dog, sheep, ox, goat, deer, horse, rat, mouse, rabbit, and from some wild carnivores and insectivores.

The presence of Demodex in man occasions no discomfort and is without importance. The variety on the horse was reported especially during the war when so much intensive work

was done on Sarcoptic and Psoroptic mange. Abroad Demodex has been recorded as giving rise to trouble on cattle. The worst Demodex, however, is the dog variety or species *Demodex canis*.

Demodex canis.—At least two forms of skin affection due to Demodex are met with in the dog, a squamous or scaly form and a pustular form.[1] In the case of the squamous form the Demodex mites are found on microscopic examination of a properly taken skin scraping; in the pustular form the mites—the microscope is always necessary—are found in the cheese-like pus squeezed out of the pustules. The disease in the dog is associated with a pyogenic bacterium [2] (*Staphylococcus pyogenes albus*). The Demodex mites not only dilate the follicles and glands and thus make entry to the tissues easy for the bacteria, but the mites may carry in the bacteria. The number of mites present in a single follicle or gland varies from 20 to high numbers. This

FIG. 1.—*Demodex folliculorum.*
Greatly magnified. (After Lohmann in "Das Tierreich.")

mite of the dog measures only $\frac{1}{100}$ inch or a little over this. All the stages——larva, nymph, and mature males and females—may swarm in the sebaceous glands and hair follicles, the females especially fixed by their beak which is directed downwards. Attack is chiefly on young dogs, and while all breeds suffer, the disease is more frequent on short-haired than on long-haired dogs. I have frequently seen cases of follicular mange on bull-dogs and one bad case on a Newfoundland dog. Beginning about the head, particularly in the neighbourhood of the eyes, the disease extends little by little to the forelegs, feet, sides and to the other parts of the body. In the beginning there is only a very slight itching (there is nothing like the intense itching associated with the Sarcoptidæ manges). There is a slight loss

[1] *Encyclopædia of Veterinary Medicine, Surgery and Obstetrics*, edited by George H. Wooldridge, vol. i, p. 457. Mange and Allied Mites, by A. W. Noel Pillers, p. 13.

[2] Mites injurious to Domestic Animals. *British Museum* (*Natural History*) *Economic Series*, No. 13, by Stanley Hirst

of hair (this may increase), the bare places being marked by a redness. With the spread of the disease there is a distinct wrinkling of the skin, and crusts mark the places where pimples or pustules have burst and the purulent matter has exuded. The patient gives off an odour suggestive of mice.

Although follicular mange is little contagious, attack is very dangerous, as the disease is one of the most obstinate and difficult to cure. Cases have come under my notice that have not yielded to a three months' most careful treatment.

Ticks or *Ixodoidea*.—This super-family of mites contains the giants among the Acarines, the ticks as a rule being much larger than most mites. Ticks have importance for the agriculturist and for the student of veterinary and human medicine because they are blood suckers. Some use as hosts cold-blooded animals like the serpent, the tortoise and the lizard, but far the greater number feed on warm-blooded animals, viz. mammals (including man) and birds. Ticks can be harmful in various ways : the host animal loses blood; the host animal is irritated by the feeding tick; suppuration, ulcers and blood-poisoning may follow the wound made by the tick's mouth-parts, especially so if in the attempt to pull away the tick the mouth-parts remain behind in the wound; fever and paralysis may be accompaniments of the bite; the tick may act as the carrier of parasites that cause dread diseases in stock. At least 20 different kinds of tick are capable of acting as disease carriers to human beings or to domesticated animals, although some of these have only been shown to act as carriers in experimental conditions in the laboratory.

Ticks are divided into two families easy to distinguish, thus :—

Argasidæ.	*Ixodidæ*
Head with mouth-parts not visible from above, so that the visible front end has a blunt appearance.	Head with mouth-parts visible from above.
No scutum or shield on the upper surface (see later).	A scutum or horny shield on upper surface.
No pad between the claws of the feet.	A pad present.
Do not swell up when feeding.	The females gorge themselves on blood, swelling to the size of a bean, so that the basal joints of the legs become widely separated.
Night feeders, and dropping off after a meal to hide in crevices, sand, dust, beds, matting, i.e. tending to remain in the nests or lair of their host.	Living more on the host, to which they may remain attached for days, only dropping away to moult or lay eggs.

Two of the Argasids carry blood parasites that can be fatal. The Fowl Tick (*Argas persicus*) of Africa, Asia, and America is a cause of great loss in fowls following mass infestation; and by the conveyance of the Protozoan parasite *Spirochæta gallinarum*, which may carry off broods. The bite of this tick is painful for man. Another Argasid named *Ornithodorus moubata*, mentioned by Livingstone in his travels, is the carrier to man of the parasite

Spirochæta duttoni, which is the cause of relapsing fever. Spirochœtes taken in by the blood-sucking female tick reach the developing eggs of the tick and pass by way of the egg to the young ticks, and these in their first nymphal stage communicate the disease to a new patient. Ticks which harbour the Spirochæte remain infective to the third generation. Among Argasids the Pigeon Tick (*Argus reflexus*) has been recorded from Kent, but it is with the family Ixodidæ that we in Britain are concerned, and we shall use the so-called European Sheep Tick, *Ixodes ricinus*,[1] to illustrate the general structure and life history of ticks of this family.

I. ricinus may be found on a number of hosts—sheep, ox, goat, dog, horse, rabbit, hedgehog, mole, birds; occasionally on wild cat, polecat, stoat and badger. Man may also be bitten.

The male measures $\frac{1}{10}$ inch long by $\frac{1}{18}$ inch broad. The body is dark brown or dark red brown in colour, and almost covered on the upper surface by a horny shield (scutum); the shield is shiny and shows, when magnified, a number of small dots or punctures. There are eight legs, each ending in two claws with a pad between them. On the under surface between the third pair of legs is the genital opening with a plate in front of it and a larger broad plate behind.

The female measures in length from about $\frac{1}{8}$ inch when fasting up to about $\frac{1}{2}$ inch when gorged with blood. The scutum is small, being confined to the front part of the body just behind the head. As the greater part of the upper surface is without the hard horny shield the body of the female is able to become greatly distended when, in feeding, the blood pumped from the wound by the suctorial pharynx passes into the paired pockets which open from and along each side of the alimentary canal. The reproductive opening is far forward on the under side between the fourth pair of legs. In the sexual adults the breathing tubules open in spiracles close to the hind legs; the anal opening is on the under surface near the hind end, with a groove known as the anal groove running round in front of it.

Mouth-Parts.—Ticks can be distinguished from all other mites or acarines by the nature of their mouth-parts. These consist of a pair of protrusible chelicerœ, each of which consists of a shaft and a digit; the digits or end pieces are divergent and toothed on the outer edge; under these in the middle line is the hypostome, which bears rows of recurved teeth. There is also on each side of the head region a palp, sensory in function. When a tick proceeds to feed, the skin is cut by the chelicerœ and then the hypostome is introduced to the wound and gives anchorage. It is the hold of the recurved teeth of the hypostome which make it unwise to pull a tick away by the body; the body breaks away from the head and the mouth-parts are left in the wound and festering follows. A drop of oil placed on the front

[1] Ticks, by C. Warburton, M.A., in *Encyclopædia of Veterinary Medicine, Surgery and Obstetrics. Ticks*, Nuttall and Warburton, 5 volumes, Cambridge University Press. Leaflet No. 145, Ministry of Agriculture.

part of the tick will make the tick leave go; a tick left to itself has no difficulty in withdrawing the hypostome.

Life History.—Mature males and females meet and couple on the host, but pairing may take place away from the host, at any rate in experimental conditions. The males, on the host, seek the females, which are fixed and feeding and distending. The small males in pairing are found attached on the underside of the female (Fig 2). The gorged and fertilised females fall away and seek shelter places in crevices at the base of grasses or under cover of stones or in the surface layer of the soil, and after a period of rest proceed to their egg-laying. The eggs are laid one by one, each being received in turn by a special organ—a protrusion from the back of the head region—which not only grips but lubricates the egg; thus the eggs stick together as they are pushed back on to the scutum. The egg-laying lasts

FIG. 2.—*Ixodes ricinus in copula.*
Eight times natural size. The small male is seen attached on the under-surface of the larger female.
From nature.

from a fortnight to a month or more according to the environment.[1] A large number of eggs can be laid, 1,000, 2,000, 3,000 being figures given in the literature (other species of ticks lay a far greater number of eggs in consonance with the grave risks in the life history). From the egg—in a month to much longer, according to the temperature—hatches a larva with six legs but no spiracles nor reproductive opening (Fig. 3). After a short restful period the larval ticks, desirous of a meal, swarm up blades of grass or other vegetation and with extraordinary patience wait the passing of a host animal, on which the larvæ fasten and feed. By a week the larva, satisfied with its meal of blood, leaves go and falls away and in course of time moults, a nymph appearing with eight legs and two spiracles from which breathing tubes and tubules branch to all parts of the body; but the nymph is still immature. The nymph in time seeks a host, and, replete with

[1] *Ticks*, Nuttall and Warburton, vol. 2, p. 311.

blood, may drop away from its host in about a week. Another resting period is passed through, during which under cover of the nymphal skin, internal changes are taking place that result, on the moulting of the nymph, in the appearance of the sexual adult male or female. Once again—as adult—the tick has to reach a host. The males feed comparatively little, but the females gorge themselves on blood (they have to lay the eggs and furnish these with reserve for the development of the larva). The adult females choose as chief places of anchorage the face, root of the ears, inside of thighs, viz. places where the wool is not thick, and having mated fall away, to proceed later

FIG 3.—Larva of *Ixodes ricinus*.
Greatly magnified The two palps and mouth parts are seen and also, towards the hind end, the anal opening
From nature.

to the laying of their eggs Most ticks, like our Ixodes, pass to a host and fall away three times, as larva, nymph and adult, but there are exceptions, e.g., the larva of the Red Tick of South Africa (*Rhipicephalus evertsi*), the carrier of the parasite of East Coast fever, moults on the host, i e., new hosts are reached only by the larva and the adult; and *Margaropus annulatus*, carrier of the parasite of Texas fever, remains on the host from the larval to the adult stage before falling away for egg-laying, thus reducing the risk of not finding a host.

Length of life cycle in Ixodes ricinus.—The length of time for the laying and hatching of the eggs, the length of the different stages, the length of the resting period of the moults, the length

of time elapsing before a host is found, all vary so much according to the environment that extremes may be expected. Nuttall gives 170 days as perhaps the shortest time from egg to adult, but gives figures to show that a life cycle may take over two years.

Vitality of Ticks.—Ticks are able to endure long fasts in keeping with the fact that much waiting may have to be done before the proper host arrives. Thus in connection with our *Ixodes ricinus*, Nuttall [1] gives on Wheler's authority examples of unfed larvæ kept in moist conditions surviving for 19 months, of unfed nymphs surviving for 18 months, and of unfed adults surviving from 15 to 27 months. In conditions of dessication, however, ticks have poor vitality.

The relation of Ixodes ricinus to Disease.—I. ricinus acts as the carrier of the parasite of bovine Red Water in North Europe, including Britain. Red Water is one of a series of Protozoan parasitic diseases conveyed to different domesticated animals by different ticks, the parasites invading and destroying the red blood corpuscles of the host. In Britain bovine Red Water, as pointed out by Stockman,[2] is also conveyed by another tick named *Hæmaphysalis cinnabarina* var. *punctata*. This tick is widely distributed over Europe (it is found also in Asia and Africa), and has been taken on sheep in England and Wales. It has a wider range of hosts even than *I. ricinus*, having in Europe been recorded from sheep, ox, deer, goat, horse, hare, hedgehog, bat, missel-thrush, partridge, curlew, viper and lizard.

Hæmaphysalis differs from *Ixodes ricinus* in several respects, not too difficult to follow; its hind margin is festooned, that is, divided up into squarish areas, and *the anal groove does not pass in front of the anus but behind it.*

Ticks in Scotland have not been worked intensively. There is an interesting field of study for one keen enough and with leisure for field work. The question of the tick in relation to Louping Ill has not really been settled and is bound to come up again. The farmer, the veterinarian, the student of pathology and animal disease would find the ticks of Scotland a useful and engaging study, and the specific differences in the various stages of larva, nymph, adult male and adult female will try the mettle of the keenest systematist.

Harvest Mites (*Trombidiidæ*) **or Berry Bugs.**—This is a family of mites red in colour, some being a beautiful velvety red —"gorgeous as cardinals," as some one has said—others darker. The mandibles are pointed or claw-like and can wound, and there are prominent five-jointed palps. There is in the adult a distinct front region, the cephalo-thorax, followed by the much larger abdomen; body and legs are covered with bristles or plumose hairs. On each side of the cephalo-thorax are two eyes. The eight legs end in two small claws. The *adults* do not trouble man or the larger animals, but seem to feed upon insects of

[1] *Ticks*, Nuttall and Warburton, part ii, p. 301.
[2] Leaflet No. 145, Ministry of Agriculture.

different orders, including plant-lice. The females lay their eggs on the ground among herbage and from these hatch six-legged larvæ. These minute larvæ are parasitic upon insects, but probably while waiting in numbers on grass and other herbage for insect hosts, they may swarm on man and domesticated animals, their presence inducing great irritation. In Europe and also abroad the larvæ are very troublesome pests and have well-known common names. With us they are known as harvest mites or berry bugs. Workers in the fields become immune in time and people vary much in sensitiveness. An entomological friend of mine, after a day's insect-hunting in the East United States (the American berry bugs are no bigger than ours), was so badly attacked by the larvæ that large blisters were raised over his leg from knee to ankle and he was laid up for a fortnight. The larvæ can force their way through stockings; they do not bury themselves in the skin, although they are said to make their way sometimes into the hair-follicles and sweat glands. Whether the larvæ that attack man are able afterwards to complete their development is in dispute, but in normal conditions the six-legged larva, after a moult, appears as an eight-legged nymph, this nymph stage being preparatory to the adult.

The larval berry bug in Britain is named *Leptus autumnalis*, whose adult stage is known as *Trombidium holosericeum*. The adult in addition to the characters given above is recognisable by the anterior region—the combined head and thorax—carrying the two front pairs of legs, while the abdomen carries the two hind pairs of legs. Complaints regarding the Leptus larvæ reach me most commonly in late summer and early autumn. Leptus is troublesome all over the country, but the south-eastern counties of Scotland have more than their fair share of the mite. The larvæ puncture the skin, and the red blisters give rise to so much irritation and discomfort that workers are disinclined for harvest work and gardeners and owners of fruit gardens dare not pluck their own fruit; my correspondence tells me of holiday-makers who, because of this mite worrying their young people, have given up their rooms and cut short their holiday.

The Leptus larvæ may swarm in summer and autumn in long grass, bracken, nettles, gooseberry and currant bushes, raspberry canes and beans, and from these plants pass to human beings—women and children are specially sensitive—and to such animals as the horse, ox, dog, cat, hare and rabbit. Attack may persist till October and even later in shady places under trees not reached by frost. Dogs, especially hunting dogs, harbour the parasites on nose, head, belly and feet. On the cat they give rise to wounds at the root of the tail and on the feet between the claws. Dr. Johnston in the History of the Berwickshire Naturalists' Club quotes a correspondent regarding this mite, thus: "In the worst case I have ever seen, that on a horse, the skin seemed exactly as if it had been rubbed with a liquid blister." In the Continental and American literature chickens and fowls are named as being much annoyed by the berry bugs fixing them-

selves at the base of the feathers and burying their mouth-parts in the skin.

Treatment.—Irritation is relieved by a salt water bath or by bathing in water to which ammonia has been added, or a hot water bath with abundance of soap. Ammonia touched on the itching and smarting part is effective. As a preventive some dust sulphur down the inside of their stockings. To prevent the mites from ascending the leg field workers bind tarred twine round their ankles.

Fowl Mites (*Dermanyssidæ*).—Here comes the Red or Chicken or Poultry Mite (*Dermanyssus gallinæ*), often a great pest in a poultry house, where its presence may be indicated by the specks of black and white excrement—if the mites are numerous—and by the falling away in condition and egg laying owing to irritation and loss of blood, for this mite is throughout its life a blood sucker. The Dermanyssus mite measures $\frac{1}{50}$ inch in length, and is grey or grey yellow in colour when fasting, but red when gorged with blood, hence a popular name, the Red Mite. The wounds are made by the mite's mandibles, which differ somewhat in the two sexes, those of the male being claw-like and in the female stiletto-like. The mites rest in the daytime in crevices in the roosts or in cracks in the wall, where careful looking—in mass infestation—may reveal clusters of resting mites and their eggs and the pale moulted skins of the larval mites. At night the mites swarm on to the fowls for feeding purposes, and when they have finished their meal—in a night but sometimes longer—leave the host for their shelter places. Sometimes the mites can be found worrying sitting hens in the daytime.

The shelter places of the mite are the breeding places. Pairing takes place and eggs are laid; the eggs hatch into six-legged larvæ, which in time moult into an eight-legged stage which after another moult yields the adult. In favouring conditions of temperature and a certain amount of moisture and darkness, development is rapid, so that a life-cycle can be completed in from a week to a fortnight. *Dermanyssus gallinæ* can survive for several months in the poultry house in the absence of birds.

Treatment.—Keep houses dry, and exposed as much as possible to the light.

Clean away all rubbish—the mites often collect in litter—and spray perches and walls with paraffin or paraffin emulsion or with a 5 per cent. solution of creolin.

Linguatula lanceolata (*Pentastoma tænioides*).—The Linguatulids—from the shape of the adults sometimes known as "tongue worms"—form a curious outlying set of uncertain Arachnids. They are interesting from their degraded structure and their curious life history. One of them, *Linguatula lanceolata*, came to me recently taken from the nostril of a fox-terrier, which till the removal of the parasite had been showing signs of much irritation and discomfort.

The adult is made up of a series of rings, the female measuring

three inches and over in length, the male less; the elongated ringed body—suggestive of a worm (tænioides means like a tapeworm)—is broadened out and rounded in front, the hind part is thinner and tapering. On each side of the mouth is a pair of retractile hooks. The adult is found in the nasal fossæ of the dog (it has been taken in horse and sheep and man).

Eggs reach the outside in the mucus from the catarrh due to the presence of the parasite. They may fall on pasture or feeding ground and be taken up by some herbiverous animal, in the stomach of which they hatch, yielding a larva with rounded body, a primitive piercing apparatus, and two pairs of lateral hooked legs. This larva bores through the wall of the gut and becomes encysted in some organ, e.g. liver or lungs, where it undergoes changes that result in a stage more closely resembling the adult. Maturity is only attained when the parasite reaches the dog's nostril. How the nostril is reached is still somewhat uncertain.

The presence of the parasite in the nasal cavity of the head causes irritation, sneezing, interference with respiration; the dog keeps rubbing its nostrils with its paws.

The larva situated in some internal organ is out of reach of treatment. In the abattoir organs containing the parasite should be condemned.

Affected dogs should be kept off pastures. To relieve them ammonia or benzine may be injected up the nostril. In time the parasite—or parasites, for there can be several in the nasal cavity—is passed out of the dog's nostril and relief and recovery follow.

THE RELATIVE VALUES OF VARIOUS GRAIN MIXTURES FOR CHICKS.

H. F. Newbigin, N.D.D.,

Edinburgh and East of Scotland College of Agriculture; and

R. G. Linton, M.R.C.V.S.,

Dept. of Hygiene, Royal Dick (Veterinary) College.

In an earlier paper (1) it was indicated that when chicks were offered a mixture of grains they showed a marked preference for some and an equally definite distaste for others. The foods used for the trial were:—canary seed, millet (*Panicum miliaceum*), dari and hemp, which were given in the natural undecorticated state, split lentils and peas, kibbled maize and wheat, polished rice, groats and linseed. These foods were selected because they were found to be the most common constituents of commercial chicken grain mixtures (2). In a record of that experiment we showed that millet, canary seed, dari and hemp (the last named being found to be more eagerly consumed during the

winter than in the summer) were the most attractive foods, that lentils, peas, maize and linseed were the least popular (the quantity of linseed eaten was negligible), and that the remainder, rice, groats, and wheat, took intermediate places in selection.

It was decided to carry out a feeding trial with chicks to determine if possible (*a*) whether the seeds chosen in the previous trial had a higher nutritive value than a mixture of the seeds that were not eaten by the birds, and (*b*) to collect information for a scheme to ascertain the best grain mixture for young chicks.

On April 3rd, 1928, 51 sex-linked cockerels (Brown Leghorn —Light Sussex) with 9 Brown Leghorns were divided into three groups of twenty, there being three Brown Leghorns in each group. The chicks were placed in brooders on grass, the runs being contiguous so that the birds were kept under the same conditions as regards soil, grass and exposure. The seeds given in the three groups were :—

Group I.	*Group II.*	*Group III.*
Dari.	Dari.	Groats.
Millet.	Millet.	Lentils.
Canary.	Canary.	Rice.
Hemp.	Hemp.	Peas.
Groats.		Wheat.
Rice.		Maize.
Lentils.		
Peas.		
Wheat.		
Maize.		

The dari, millet, canary seed and hemp were given in the natural undecorticated state. The foods were carefully mixed in equal proportions by weight and the chicks were given a liberal supply, weighed out to them daily and increased periodically, so that they had as free choice of the various seeds as was practicable. The grains were put into shallow open boxes. The birds were weighed in groups every fifth day and the residual food was sent to the laboratory daily, where it was cleaned and weighed in order to record the weight of food consumed. This method of feeding was continued for 55 days, and then on June 6th the grain mixture was stopped.

There was one death in Group II on April 18th and one in Group III on April 28th; the records of growth and of daily food consumption are averages based on the number of birds alive in each group on the day of recording.

The mixed foods of each group were found to have the following composition :—

TABLE 1.

	Moisture.	Crude Protein.	Ether Extract.	N. Free Extract.	Fibre.	Ash.
Group I	9·56	15·75	6·60	61·11	4·20	2·78
Group II	10·32	14·87	9·70	53 46	7·70	3·95
Group III ...	10·10	16·60	2·93	67·49	1·03	1·85

At the beginning of the trial the average weight per chick in each group was:—Group I, 38·2 grams; Group II, 38·6 grams; and Group III, 38·6 grams. It became evident within a fortnight after hatching that the chicks of Group I were thriving better than those in the other two groups, and that the birds in Group II were not doing so well as those in Group III; throughout the experiment with the grains this order was maintained. On the 55th day when the grain mixture was stopped the average weight of the chicks in Group I was 550 grams, showing a gain per chick of 511·8 grams; in Group II 445 grams, a gain of 406·4 grams per chick; and in Group III 520 grams, the average gain per chick being 481·4 grams.

It is therefore obvious that the complete mixture of grains given to Group I was the best diet judged by capacity to produce live weight increase. Ration No. II composed of dari, millet, canary seed and hemp, which in the previous trial the chicks preferred to the other seeds, apparently failed to justify the birds' choice of food; nevertheless it is clear that the addition of these four seeds improved the diet of Group III, inasmuch as the combined diets of II and III given to Group I produced the best results. While the periodic weighings gave definite evidence of the superiority of the mixture, it was easily possible by a mere inspection of the three groups of chicks in their runs to say which lot was doing better than another, the difference in appearance being so marked.

The amount of food consumed per chick, the total gain in weight for the period 5th to the 32nd day inclusive, the average daily gain in weight, and the quantity of food consumed per gram of live weight increase is given in Table II.

TABLE II.

	Average total gain per chick.	Food consumed.	Average daily gain.	Food consumed per gram of live weight increase.
	grams.	grams.	grams.	grams
Group I	190·8	473	6·8	2·48
Group II	139·0	353	4·9	2·54
Group III	169·8	440	6·0	2·59

After the 55th day, when the grain feeding was stopped, the birds were given a dry mash of proved utility composed of:—

Ground Wheat	35
Maize Meal	20
Sussex Ground Oats	30
Alfalfa Meal	10
Meat and Bone Meal	5
	100

and having the following chemical composition :—

TABLE III.

Percentage Composition of Dry Mash.

Moisture.	Crude Protein.	Ether Extract.	N. Free Extract.	Fibre.	Ash.
11·87	12 69	4·66	60·52	6·76	3·50

Throughout the experiment each group was allowed separated milk *ad lib.* in accordance with the usual custom of chicken rearing. The amount of milk consumed by each group was not recorded, but it was noted that Group I drank very much more than either Groups II or III.

Groups II and III failed to make up on Group I, even though the trial was continued to the 117th day, thus emphasising the importance of suitable feeding in the earliest stages of life.

The change of diet, however, had a definitely beneficial effect on Group II; in fact the average daily live weight increase, taken over a period of the first 30 days after the change of diet, was slightly greater than that of Group III. This is shown in Table IV.

TABLE IV.

Record of Growth from the 55th to 85th day.

	Average weight on 55th day.	Average weight on 85th day.	Total Average gain.	Average gain per chick per day.
	grams.	grams.	grams.	grams.
Group I	554	955	401	13·3
Group II	149	830	381	12·7
Group III	522	900	378	12·6

The relations of the groups to one another as regards food consumption is similar to those of the live weight increases, and apparently, therefore, the increase in weight was in direct proportion to the quantity of food consumed and not to any particular merit in the foods themselves, except that the composition of the foods may be a factor in satisfying appetite.

Summary.—(1) When the food of newly-hatched chicks was limited to mixed " grains " and separated milk, a mixture of dari, hemp, millet, canary seed, groats, rice, lentils, peas, wheat and maize gave better results, judged by live weight increase, than either mixture of dari, millet, canary and hemp or of groats, lentils, rice, peas, wheat and maize; a mixture of groats, lentils, rice, peas, wheat and maize gave better results than a mixture of dari, millet, canary and hemp.

(2) After the groups of chicks had been fed on the grain mixture for 55 days and then given a dry mash of known utility, the two backward groups failed to make up on the best group,

thus emphasising the importance of suitable feeding during early life.

(3) A feeding trial with a mixture of dari, hemp, millet and canary seed apparently failed to justify the birds' selection of these shown in a previous paper.

REFERENCES.

1. The Palatability of Certain Seeds to Chicks H. F. Newbigin and R. G. Linton. *The Scottish Journal of Agriculture*, vol x, No. 4, October 1927.

2. The Composition of Poultry Mixed Grains. R. G. Linton. *The Scottish Journal of Agriculture*, vol. viii, No. 4, October 1925.

MILK SUBSTITUTES IN THE REARING OF CALVES.

J. B. ORR, D.S.O., M.C., M.D., &c., and
A. CRICHTON, M.A., B.Sc.,
Rowett Research Institute, Aberdeen; and

Prof. E. SHEARER, M.A., B.Sc., and Miss M. SPEEDY, C.D.A.,
Edinburgh and East of Scotland College of Agriculture.

IN common practice it usually takes from 100 to 150 gallons of milk to rear a calf. In farms where there is an ample supply of separated milk as a by-product in butter making, its utilisation for calf rearing is economical, and as the market value for separated milk is low, there is no reason to stint the amount of milk given to the calf. In cases, however, where all the milk can be sold as whole milk, the amount used in rearing calves is a matter of economic importance, and it is necessary to cut down the amount of milk consumed to the lowest level compatible with health and satisfactory rate of growth.

As milk is the natural food prepared by nature for the calf, it would not be expected that substitutes would give as good results. But the value of milk depends upon the fact that all the essential nutrients required for building up the bones and tissues of the calf are present in the exact amounts and proportions required by the young animal. Hence the more nearly the composition of milk substitutes approximates that of milk the better will be the results obtained in health and rate of growth. Maynard and others in America obtained satisfactory growth by substituting for part of the milk ration a gruel, made up without reference to the composition of milk, but which consisted of easily digestible protein substances together with added mineral matter. By this method they were able to cut down the total amount of milk consumed by a calf to about 50 gallons.

The meals commonly used for calf-feeding are, if milk be taken as a standard, usually very badly balanced, being deficient in certain essential nutrients. In order to determine whether

by balancing up with appropriate supplements the meals usually fed to calves could be improved, certain experiments were carried out in Edinburgh and Aberdeen. It was thought that if these meals used as substitutes could be improved, the amount of milk required to raise a calf could be considerably reduced.

In these experiments the basal ration for the first few weeks consisted of oatmeal and linseed meal made into a gruel, and afterwards crushed oats and linseed cake with hay *ad lib.* This was taken as a diet which would be commonly fed to calves during and after weaning. Compared with milk, this ration is deficient in good protein and mineral matter and probably also in certain vitamins found in milk. A supplement consisting of an appropriate protein and mineral mixture and cod liver oil was used to make the composition of the ration more like that of milk.

The protein and mineral mixture was as follows :—

Blood meal	10·18	parts.
Chalk	2·40	,,
Potassium chloride	1·15	,,
Steamed bone flour	0·66	,,
Sodium chloride	0·50	,,
Ferric oxide	0·10	,,
Potassium iodide	0·01	,,

The above mixture was added to the meals in the proportion of 7·5 parts of the mixture to 100 parts of the meal. The cod liver oil was fed at the rate of $\frac{1}{8}$ oz., rising after eight weeks to $\frac{1}{4}$ oz. per head per day.

Experiment I.—Edinburgh.—The object of the experiment was to determine the effect of this addition to the basal ration on calves receiving only 50 gallons of milk per head. As a control or standard in which the optimum rate of growth might be expected, a group of calves was given 150 gallons of milk per head. The groups in the experiment were therefore as follows :—

Group A.—150 gallons whole milk per head weaned on to the meals.

Group B.—50 gallons whole milk per head weaned on to the meals.

Group C.—50 gallons of whole milk per head weaned on to the meals plus the supplement of protein and mineral mixture and cod liver oil.

In each group there were five calves seven to ten days old at the beginning of the test. The animals were fed indoors. They were allowed out for short periods for exercise but were not allowed to graze. The test is, therefore, a test on indoor feeding.

In the first four weeks all the groups received the same amount of milk. From the fifth week onwards the milk allowance to Groups B and C was rapidly reduced, and by the end of the seventh week the total allowance of 50 gallons per head had been consumed. From then onwards the calves of Group B

received only the ration of linseed meal and oats with hay *ad lib.*, and the calves in Group C the same ration plus the supplement. In Group A the milk continued to be fed until the eighteenth week, by which time the allowance of 150 gallons per head was consumed and the ration became the same as Group B, i.e. linseed, oats and hay.

The test was run for 175 days, by which time it was obvious that the calves in Group B, i.e. low milk and no supplement, were in a greatly inferior condition to those in the other two groups, and additions were made to the ration. As this altered the nature of the experiment, the further results need not be considered here.

The following table gives the average gain in weight for (*a*) the four weeks period when the animals were all receiving the same amount of milk; (*b*) for the next fourteen weeks when the milk feeding was continued in Group A and cut off in Groups B and C after three weeks; and (*c*) for the remaining seven weeks when the groups were on the same ration except that the supplement was fed to Group C.

Average gains in weight in lbs.

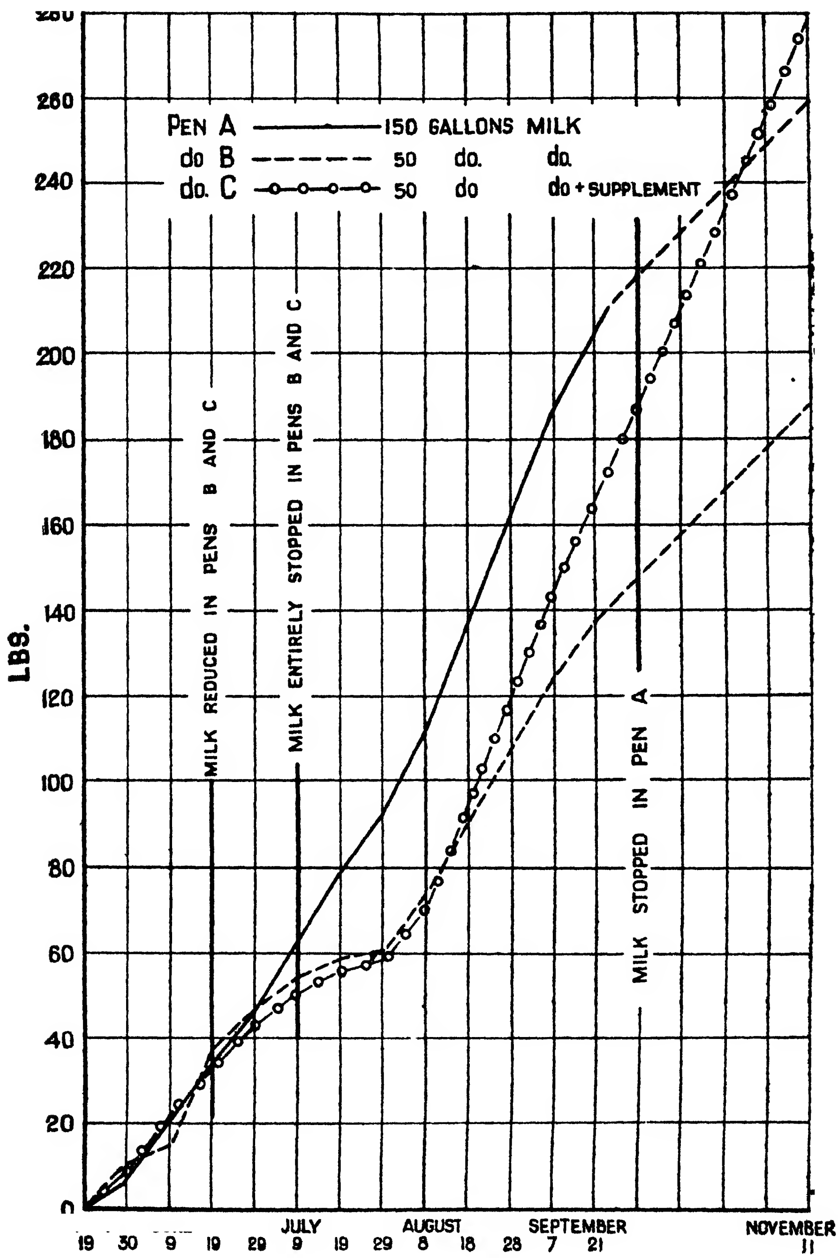
	Group A.	Group B.	Group C.
	150 gallons of milk + ration.	50 gallons of milk + ration.	50 gallons of milk + ration + supplement.
First 4 weeks. All receiving same amount of milk ...	35	38	34
Next 14 weeks. Milk continued in A. Cut off in B and C after 3 weeks ...	174	105	143
Next 7 weeks. A and B—ration only. C — ration + supplement	48	43	97
Average gain over whole period ...	257	186	274

The result is shown in the accompanying graph.

It will be seen that when the milk was reduced and finally cut off in Groups B and C there was an immediate fall in the rate of growth as compared with Group A. After a few weeks, however, Group C, receiving the supplement, recovered and began to grow at the same rate as Group A, receiving the milk.

When the milk was cut off from Group A, the rate of growth in Groups A and B, both on the same ration, became parallel, and at a slower rate than that of Group C, receiving the supplement. By the end of 25 weeks this group receiving the supplement had made good all the leeway, and the animals were actually on an average 17 lbs. heavier than those in the group which had received the 150 gallons of milk. Unfortunately no weighings

Average Gain in Weight Per Calf



were carried out during the period 21st September to 11th November, so that the curve for Group A shows a decreased rate of growth before the milk feeding was actually stopped. The latter part of this curve is therefore dotted.

Experiment II.—Rowett Institute.—A similar experiment was carried out at the Rowett Institute, where, however, owing to lack of accommodation it was impossible to have more than six calves, which were divided into two groups corresponding with B and C in the above test. This experiment, therefore, merely tested the effects of the supplement. The number of animals is too small to give reliable results. The data, however, may be quoted in confirmation of the larger test at Edinburgh.

Weights in lbs.

	Pen A.	Pen B.
	Basal.	Basal + supplement.
Average initial weight per calf	80	80
Average weight after 131 days	213	242
Average gain per calf	133	162

At the end of the 131 days it was obvious that the animals in Pen A were in a markedly inferior condition to those in Pen B, and the test was terminated at this stage.

Experiment III.—Edinburgh.—This experiment was carried out to determine whether the beneficial results which had been obtained with the supplement in the above two experiments in indoor feeding would be obtained in the case of calves kept outdoors on good pasture in summer.

One group of ten calves received the oatmeal and linseed meal ration only. Another group of ten received the supplement mixed with the meals. Both groups received the same amount of milk viz: 50 gallons per head.

The test was continued for 58 days, after which the calves were taken inside. The following table shows the average rate of gain in the two groups:—

Weights in lbs.

	Group A.	Group B.
	Basal.	Basal + supplement.
Average initial weight per calf	158	159
Average weight after 58 days	241	248
Gain per calf	83	89

It will be seen that although there is a slight effect of the supplement, it is nothing like so marked as in the case of indoor winter feeding. This is the result which would be expected as the composition of good pasture is very similar to that of milk, so that the pasture would make up the deficiencies in the meal ration.

Palestine Experiments.—In certain calf feeding experiments in Palestine carried out by Mr. John Crichton of the Rowett Institute, in which the same supplements were tested, it was found that by the use of these supplements it was possible to cut down the milk given to calves from 100 gallons to 50 gallons and yet obtain equally good results with the calves. The following table shows the result of one of the experiments carried out :—

Weights in Kilograms.

	Group A.	Group B.
	Basal + 100 gallons milk + supplement.	Basal + 50 gallons milk + supplement.
Average initial weight per calf ...	29·3	29 3
Average weight after 130 days ..	99·0	98·5
Average gain per calf	69·7	69·2

Where the supplement, however, was not used, the rate of growth of the calves slowed down and the animals became unthrifty. In those Palestine experiments the animals were allowed outside but received no green food.

The Effects of Supplements on Animals in Later Stages of Growth.—Reference should be made here to other four tests which were carried out in Aberdeenshire and Dumfriesshire to determine whether the results obtained on young calves by the use of this supplement would be obtained on older animals. Three of these tests were carried out at farms. Mr. Durno of Crichie, Mr. Kirkpatrick of Sanquhar and Mr. Maitland Mackie of Tarves kindly provided the animals, accommodation and foodstuffs.

In one test with half-grown animals which came off very poor pasture and were in poor condition at the beginning of the test, a definite positive result was obtained by the use of the supplement. In three other tests, however, in which the animals were in good condition at the beginning, no definite result was obtained during the short period of the test. These negative results are referred to here in order to emphasise the fact that supplements such as the above may give excellent results in very young animals, but may give no result in older animals. This is due to the fact that in older animals the requirements for the constructive material contained in the supplements are relatively less than in younger animals which are growing at a faster rate in proportion to their body weight.

In these preliminary experiments whole milk was used because it is the natural food of the calf, and it was desired to get as near as possible to the optimum rate of growth in the control group. In actual practice, of course, separated milk which contains all the constituents necessary for bone and tissue formation could be substituted for whole milk after a short period following birth. In feeding tests with young school

children the results with separated milk were almost as good as those with whole milk.

Conclusions.—(1) The addition of appropriate supplements of protein, minerals and cod liver oil improves an oatmeal and linseed ration fed to young calves.

(2) By the use of such a supplement the quantity of milk required to rear a calf can be reduced.

(3) The maximum beneficial effect of this supplement was noted in the case of young animals fed indoors during the winter. In young animals grazing on good pasture little effect of the addition of the supplement was noted, the pasture supplying all the constructive material required.

(4) In the case of half-grown animals off good pasture the effect of adding the supplement to the ration was negligible.

Note.—The authors are indebted to Mr. J. S. Thomson, Rowett Research Institute, for preparing this paper for publication.

GERMICIDES AND ANTISEPTICS.

JAMES F. MALCOLM, M.Sc., N.D.A., N.D.D.,

West of Scotland Agricultural College.

MANY chemical substances even in low concentrations are harmful to bacteria. Some rapidly bring about their destruction and are accordingly termed germicides, bactericides or disinfectants. Others, not so powerful, check the growth and mutiplication of germs and even destroy their cells, but have little or no effect on their spores; they prevent sepsis (putrefaction) and are therefore termed antiseptics. Some antiseptics are used for the preservation of food and must necessarily be non-poisonous to human beings in the concentrations in which they are used.

The effect of germicides and antiseptics on bacteria varies widely according to conditions and no hard and fast line of distinction can be drawn between them. Under certain conditions a solution may have a germicidal action, destroying all forms of bacterial life, including spores; under other conditions it may have an antiseptic action, merely preventing growth. For these reasons the term antiseptic is used in the following notes in referring to a germicide and disinfectant as well as to an antiseptic.

Factors influencing the Action of Antiseptics.—The action of antiseptics on germs is influenced greatly by many factors, and such substances can be used effectively only when these factors are taken into consideration. The fact that a substance, such as lysol, is labelled disinfectant merely indicates that it will destroy all forms of bacterial life provided it is used under certain conditions.

The higher the concentration of an antiseptic up to a point

the more harmful it generally is to bacteria. A substance in dilute solution may even act as a stimulant to bacteria, whereas in stronger solution it acts as a preservative and in still stronger solution as a germicide. The harmful action, however, is not in proportion to the concentration. A 10 per cent. solution of such a substance is not necessarily twice as effective as a 5 per cent. solution. In some cases it is more than twice as effective, in other cases less. Two substances therefore may have the same antiseptic power at one concentration and different powers at another. If watery material, e.g. liquid excrements, is being sterilised, the antiseptic should be used in much higher concentration or in much larger quantity to compensate for the diluting effect of the water.

In some cases the strength of the antiseptic is increased by mixing it with others, so that a solution of say 5 per cent. of the mixture is more powerful than 5 per cent. solutions of each substance separately. It is, however, better in practice to avoid mixing different antiseptics, as reactions may result which produce substances of little or no antiseptic value.

The strength of some antiseptics, for example, chlorine, sulphur dioxide and formaldehyde, is greatly increased by the presence of water, provided it is not in excess. Most antiseptics are much more powerful in aqueous solution than in glycerine, vaseline or oil. A solution of carbolic acid in water is much more powerful than carbolised oil or vaseline. It is of considerable interest that the strength of an antiseptic is not reduced by mixing it with lanoline, owing perhaps to the fact that the latter contains water intimately mixed with the fat. An alcoholic solution of an antiseptic is generally much less harmful to germs than an aqueous solution, in spite of the fact that alcohol itself has mild antiseptic properties. Moreover, the antiseptic power of the alcohol is generally reduced by the presence of dissolved substances. The antiseptic action of a solution of carbolic acid or corrosive sublimate in methylated spirits is due chiefly to the alcohol, such a solution being scarcely more powerful than the spirits alone.

The antiseptic action of a substance may be greatly affected by the reaction of the material in which the germs occur, and therefore for general disinfection work antiseptics, such as lysol and cresol, which are not greatly affected in this way should be used.

When the material in which the germs occur consists largely of organic substances, especially proteins, as in the case of excrements, blood and suppurative matter, much of the antiseptic may enter into physical or chemical combination with these substances and thereby be rendered inert. Moreover, insoluble products may be formed, for example, as a result of the action of corrosive sublimate on proteins, which may prevent the still uncombined and therefore still active antiseptic from reaching the germs. While most antiseptics are rendered less effective by the presence of such organic substances, some are affected

more than others. Mercuric chloride, chlorine and iodine are affected much more than carbolic acid and lysol. In disinfecting such material a suitable antiseptic, such as lysol or saponified cresol, should be used in high concentration and in excess, and intimately mixed with the material to ensure that it reaches all the germs.

The presence of grease around the germs may prevent the antiseptic from reaching them, unless it is capable of dissolving or emulsifying fat. Soap has little antiseptic power, but it is included in some antiseptics, for example, lysol, as it enables them to emulsify grease and thus reach the germ.

It is very difficult to disinfect solid matter if antiseptics do not readily penetrate into its substance.

Higher temperature generally increases the power of an antiseptic, which may become two or three times as powerful with a rise in temperature of 10°. If the temperature is above that at which the germs grow best, its effect is more marked, as it then not only increases the action of the antiseptic but has a directly harmful action on the germs. For disinfecting purposes, therefore, it is generally better to use a hot solution or emulsion of an antiseptic. The higher its temperature the less need be its concentration.

When germs are exposed to the action of an antiseptic, the death-rate is very high at first, and then becomes gradually lower until all are destroyed. The greater the number of germs in the material the higher should be the concentration of the antiseptic, or the longer should the material be exposed to its action. In the case of most disinfectants the strength of solution and amount used should be such as to destroy all the germs in the material under treatment within two hours, otherwise some germs may survive. If the material can be exposed only for a short time to the disinfectant the latter must be used in higher concentration or at a higher temperature.

Germs differ considerably in their resistance to antiseptics according to species, strain, condition, &c. If they are in an enfeebled condition owing to age or unfavourable environmental conditions, for example, exposure to sunlight and presence of excess of their own excretions, they are more easily destroyed. Spores are extremely resistant and constitute one of the greatest problems in disinfection, especially in connection with the disinfection of the skin and wounds. They may not be affected by even highly concentrated solutions of the weaker antiseptics such as boracic acid, alcohol, and carbolic acid. A saturated solution of carbolic acid has little or no effect on anthrax spores. An antiseptic therefore should be used in much stronger solution or in much greater amount to disinfect material, such as soil and dung, in which sporing germs are likely to be present. Two kinds of bacteria may be similar to each other in their resistance to one antiseptic, yet quite different in their resistance to another. Moreover, two antiseptics may be equally effective in the case of one germ, but not in the case of another. Some antiseptics are

especially effective against certain germs and are therefore said to be selective in action. Salvarsan, an organic compound of arsenic, for example, is especially effective against the germs causing syphilis and yaws.

The antiseptic power of a substance is increased greatly when it is readily absorbed by germs. Some antiseptics are more readily absorbed in dilute solution than in highly concentrated, so that their antiseptic power is not in proportion to their concentration. As a result of the action of physical factors an antiseptic, such as cresol, may be more powerful in the form of an emulsion in water than in solution. In such cases the finer the emulsion the more powerful is the antiseptic.

The Suitability of an Antiseptic.—The suitability of a substance for antiseptic purposes depends greatly on the circumstances in which it is used.

A general disinfectant should be so powerful that it has a rapid germicidal action even in highly diluted solution. It is possible to vary the strength of such a substance according to conditions, for example, the material being disinfected. Moreover, smaller quantities of it are required, so that it is more convenient for handling and storing and costs less to transport.

It should be readily soluble in water or capable of producing a uniform and very fine emulsion in it. In the latter case the antiseptic should not separate out from the water on storage or at low temperatures, otherwise if large quantities are being used it may be difficult to bring it back again into a fine emulsion.

The antiseptic should not readily undergo changes which would lessen its power, even when heated to 100° C. Such a substance can be used in hot solution with consequent increase in its efficiency.

An antiseptic is more effective for ordinary disinfecting purposes if, as in the case of lysol and saponified cresol, it can attack grease, and if its power is not greatly reduced by the presence of acids and alkalies, proteins and other substances. Its uses are greatly limited, especially as a household disinfectant, if it is caustic or corrosive, if it damages or discolours cloth and other fabrics, and if it acts on dyes. Materials such as textile goods, clothing, bedding and carpets constitute a difficult problem in disinfecting.

Many disinfectants, especially those prepared from coal tar, e.g. carbolic acid and cresol, are liable to vary in composition, and care should be taken when purchasing them to obtain reliable information of their purity and strength.

Most of the powerful antiseptics are highly poisonous to the higher animals. Corrosive sublimate and others are so extremely poisonous that they should not be used for domestic or farm purposes. For the purification of drinking water only relatively non-poisonous antiseptics can be used, especially those which readily become converted under natural conditions into harmless substances, as in the case of hydrogen peroxide and bleaching powder.

The ideal antiseptic for destroying germs occurring on or in the animal body would be one which was harmless to the latter. Great use could be made of such a substance in the treatment of septic wounds and diseases caused by germs, especially those diseases for which it is impossible to build up the resistance of the body by vaccines and anti-sera. Most of the powerful antiseptics are quite as harmful to the living tissues of animals as to bacteria, although to destroy the former a much larger amount is necessary. A few, however, e.g. acriflavine, are much more harmful to bacteria. A few antiseptics have such a marked selective action for certain disease producing germs that they can be injected in sufficient quantities into infected tissues to destroy these germs without appreciably injuring the tissues. Thus salvarsan can be used for the treatment of syphilis and yaws, quinine for malaria, and trypan blue for red water in cattle. Powerful antiseptics, such as lysol, can be used for cleansing the skin and infected wounds, the strength used being sufficient to destroy non-sporing germs in five minutes. They should not, however, be used as dressings, because if left for a time in contact with the skin or wound, they hinder the healing processes and even destroy the tissues. In the dressing of septic wounds antiseptics are used which are relatively harmless to the body tissues in the concentrations employed, e.g. boracic acid, tincture of iodine, eusol, iodoform and the flavines.

Antiseptics by checking putrefaction prevent the formation of bad odours. Some, however, can absorb or destroy foul-smelling substances and are therefore especially useful for disinfecting disjecta. Charcoal and many other deodorants have no antiseptic power.

Many powerful antiseptics, e.g. the salts of silver and gold, are too costly to be used except for special medical purposes. An expensive substance, provided it has very powerful antiseptic properties, may in the end be a cheap disinfectant, owing to the fact that it can be used in very weak solutions. It does not, however, follow that the more expensive a substance is the greater is its antiseptic power.

Some Common Antiseptics.—Hydrogen peroxide readily breaks down, yielding nascent oxygen to which its antiseptic properties are due. It is a useful household disinfectant as it is non-corrosive and relatively non-poisonous to higher animals. A 1 per cent. solution checks bacterial growth, a 5 per cent. solution destroys many spores within one hour. It can be used for the disinfection of foul wounds, but as its antiseptic properties are rapidly lost in presence of blood and suppurative matter, it must be applied in high concentration. It has been used for sterilizing drinking water, and is present in many medical and dental preparations.

Chlorine is a powerful antiseptic provided water is present. Owing chiefly to its low cost it is widely used as a disinfectant. Its antiseptic power is greatly reduced by the presence of organic substances, and when used for the disinfection of excrements and

blood it should be applied in excess. It is the active antiseptic agent in chlorine water, bleaching powder (commercial chloride of lime), Milton, eusol, eupad, and many other preparations. Bleaching powder reacts with acids, even carbonic acid, yielding chlorine. If left exposed to the air it absorbs water and carbon dioxide and gives off chlorine. It contains up to 35 per cent., generally 33 per cent., available chlorine, but deteriorates rapidly, especially in hot moist climates, and may ultimately contain only 20 per cent. A 2 per cent. solution of bleaching powder will destroy non-sporing germs, a 10 per cent. solution will destroy spores. It has been used for sterilizing drinking water, but flavours it and renders it "hard." It is commonly used for disinfecting animal excrements and byre and stable drains, but must be used in excess. It is a useful disinfectant in the dairy for woodwork, shelves, walls and drains. It is suitable for the disinfection of farm buildings in the case of outbreaks of infectious diseases, the walls, woodwork and all other parts exposed to the infection being washed thoroughly with a solution of at least 1 per cent. fresh bleaching powder. It is largely used in the preparation of other antiseptics suitable for sterilizing drinking water, for surgical dressings, gargles, &c. One of the most important of these is eusol, an antiseptic used for dressing septic wounds. Bleaching powder along with acid has been used for fumigating purposes, but owing to difficulties in application and doubtful efficiency this method is now seldom adopted.

Iodine is not so powerful an antiseptic as chlorine but is frequently used for medical purposes. It has been used for sterilizing drinking water. Tincture of iodine is used in surgery for sterilizing the skin and for antiseptic dressings. It owes much of its antiseptic power to the alcohol present. Iodine trichloride or terchloride is used in surgery. It is a powerful antiseptic provided blood is absent, a 1 per cent. solution destroying spores within a few minutes. Iodoform is a weak antiseptic but is most effective as an antiseptic dressing for foul wounds; under such conditions it breaks up and yields free iodine. Care should be taken in using such dressings on a dairy farm, because iodoform has a persistent and characteristic odour which will readily taint dairy produce.

The mineral acids, e.g. nitric, hydrochloric and sulphuric are not commonly used for disinfection owing to their corrosive properties. Nitric is more powerful than hydrochloric, and the latter more powerful than sulphuric. A 10 per cent. solution of such an acid will destroy bacterial spores, and can be used for disinfecting woodwork, rubber, and other material which will not become corroded. Sulphuric acid has been used in very dilute solution for purifying drinking water. The antiseptic properties of the gastric juice is due to the presence of hydrochloric acid.

Sulphurous acid is a more powerful antiseptic than sulphuric acid. It is produced by the action of sulphur dioxide on water. Sulphur dioxide has been much used for fumigation, as it can be cheaply and readily produced by burning sulphur in air, from 3

to 6 lbs. sulphur being burned for every 1,000 cubic feet of air space, or about 1½ lbs. for a room of moderate size. Sulphur burns more readily if mixed with methylated spirits. Fumigation can also be conveniently done by using liquefied sulphur dioxide. Dry sulphur dioxide has little action on germs, and therefore prior to fumigation, all exposed surfaces should be sprayed with water to bring about the formation of sulphurous acid. Under such conditions, however, this acid is generally formed in too low a concentration to have much germicidal effect. Moreover, its penetrative power is so low that it may not reach germs which do not occur on exposed surfaces. Clothing, carpets, furniture, wallpaper and dirt should therefore be removed from a room prior to fumigation, and should be disinfected by more suitable methods. The wallpaper should be burned. During fumigation the room should be sealed for at least six hours or, if possible, twenty-four hours, the chimney being closed and paper pasted round the edges of doors and windows. This is not a reliable method of disinfection, even under the best possible conditions, and it should not be used for the disinfection of farm buildings. It is sometimes used for destroying vermin.

Boracic or boric acid is a mild antiseptic. A 4 per cent. solution destroys non-sporing germs in twenty-four hours, but even a concentrated solution does not kill many bacterial spores. It is a common preservative in certain foodstuffs, but is not allowed in dairy produce. Borax, the sodium salt of boracic acid, has somewhat similar antiseptic properties.

The caustic alkalies, soda, potash and lime, are much weaker antiseptics than the mineral acids. Their uses as disinfectants are limited owing to their caustic nature. Ordinary hard and soft soaps have a very slight antiseptic action, due seemingly to their partial breaking down when in solution in water into caustic soda and caustic potash respectively. These caustic substances, however, are produced in far too small an amount, and the length of exposure to their action is far too short, for the skin to be disinfected by merely washing the hands in soap and water. The antiseptic action of soap is increased by the addition of antiseptics, such as carbolic acid, as in the case of carbolic soap, but even such preparations should not be relied upon to destroy germs on the hands, clothing, &c. Household ammonia has little antiseptic power.

Caustic lime or quick lime in presence of much water has little germicidal action. It has been used for the treatment of sewage, its chief effect being to cause many of the germs to settle out. A 20 per cent. solution in water can be used for disinfecting animal excrements. On exposure to air, quick lime becomes converted into chalk, which is harmless to bacteria. Infected carcases are sometimes buried in quicklime to prevent spread of the infection, but if spores are present they may survive for a long time and be a source of infection should the carcase be disturbed. Quick lime is used in water as a lime-wash or white-wash for the walls of byres, cattlesheds, dairies, &c. In this

form it has not a very powerful antiseptic action, and where there is an outbreak of an infectious disease, a disinfectant, such as lysol or cresol, should be added to it.

Common salt or sodium chloride is a very mild antiseptic of great use for preserving foodstuffs. A 10 per cent. solution checks the growth of most germs, but a saturated solution may not kill even non-sporing germs, such as Bacillus tuberculosis.

Saltpetre or potassium nitrate is a weak antiseptic used along with common salt for preserving bacon. It must be used in small quantities as it is poisonous to human beings.

Washing soda or sodium carbonate in a 5 or 10 per cent. solution in water has mild antiseptic properties, especially at high temperatures, due to the fact that it breaks up to some extent with formation of caustic soda. The solutions used for cleansing purposes are generally far too weak to have any antiseptic action.

Copper sulphate (blue vitriol) is not a powerful disinfectant, a 5 per cent. solution taking about five days to destroy anthrax spores. Even very strong solutions can not be relied upon to disinfect animal excrements. It is sometimes used in lime-wash for disinfecting walls, especially if much albuminous matter, e.g. blood, is present. Care should be taken not to allow it to come in contact with metal pipes or pails, otherwise it will corrode them. Copper sulphate is used, either alone or along with other substances, in fungicides for the prevention and treatment of plant diseases. The fungicide Bordeaux mixture consists of copper sulphate, quick lime and water; Burgundy mixture, of copper sulphate, washing soda and water. Copper sulphate is also much used for the prevention and treatment of foot rot in sheep. For this purpose it may be used in powdered form along with Archangel tar, or in aqueous solution either alone or along with a preparation of white arsenic and washing soda.

Mercuric chloride or corrosive sublimate is a very powerful antiseptic, a 1 per cent. solution killing bacterial spores in twenty minutes and a 0·05 per cent. solution killing many non-sporing germs in five minutes. It is not suitable for disinfecting dung, blood and pus, because its antiseptic power is greatly reduced by organic substances, especially proteins. It is too poisonous to be suitable for ordinary household and farm use.

Ferrous sulphate (green vitriol), zinc chloride and zinc sulphate (white vitriol) are weaker antiseptics than copper sulphate. They are not reliable disinfectants.

The permanganates, especially potassium permanganate, are common disinfectants. Their antiseptic power is greatly reduced by the presence of organic matter, and therefore in disinfecting excrements they should be used in excess. They are not very powerful antiseptics. A 1 per cent. solution destroys non-sporing bacteria in ten minutes. A 5 per cent. solution may take about twenty-four hours to destroy spores. Potassium permanganate can be used for sterilizing drinking water and as an antiseptic gargle. It is similar in action to the commercial preparation, Condy's Fluid.

The organic acids are comparatively weak antiseptics. Vinegar, a dilute solution of acetic acid, and lactic acid have been used from ancient times for preserving foodstuffs. The latter acts as a preservative in butter, cheese, sauerkraut and silage. Tartaric, citric, and malic acids occur in sufficient concentration in the juices of fruits to preserve them from the action of most germs with the exception of yeasts and moulds.

Alcohol has its greatest antiseptic power when used in a 40 to 55 per cent. aqueous solution. Such a solution destroys non-sporing germs within fifteen minutes, but has no effect on spores unless they are boiled in it. Absolute alcohol has practically no effect on dry spores even at boiling point. Anthrax spores may survive a four month's immersion in 50 per cent or absolute alcohol. A solution containing less than 10 per cent. alcohol may have no effect on non-sporing germs. Methylated spirits and absolute alcohol are used for disinfecting the skin but are not reliable disinfectants.

Glycerine in 25 per cent. aqueous solution is antiseptic in action, but weaker solutions may stimulate bacterial growth.

Formaldehyde is a pungent gas, readily soluble in water, a 40 per cent. solution being known in commerce as formalin. It is a good general disinfectant, as it has no effect on cloth, dyes and metals, with the exception of iron and steel, and its antiseptic power is not reduced by the presence of organic and inorganic substances. Moreover, it is not highly poisonous to the higher animals. A 4 per cent. solution of the gas, i.e. a 10 per cent. solution of formalin, destroys non-sporing germs in thirty minutes. Formalin, on exposure to the air, becomes weaker owing to formaldehyde being evolved or converted into paraformaldehyde, a relatively insoluble solid substance of little antiseptic power. If formalin is used for disinfecting the skin it should be mixed with a concentrated alcoholic solution of soap, otherwise it will render the skin hard and dry. Clothing being disinfected with formalin, should be soaked in it for at least twenty-four hours to destroy spores. The gas is a more reliable fumigant than sulphur dioxide, but is effective only provided water is present. All exposed surfaces should therefore be sprayed or washed with water or a 0·5 per cent. solution of formaldehyde prior to fumigation. If formalin is heated in open vessels it is largely converted into paraformaldehyde. This can be prevented to a great extent by heating the formalin with bleaching powder, borax, common salt or glycerine, or by mixing it with quick lime or potassium permanganate. The room during fumigation must be kept sealed for over twelve hours and should be kept warm. After unsealing the room a little ammonia sprinkled on the floor will get rid of any odour. For the disinfection of farm buildings and dairies, however, fumigation even with formaldehyde is much less reliable than the direct application of a germicidal solution of formalin, lysol or other antiseptic, in the form of a wash or spray to all the exposed surfaces, and the latter entails no extra labour, as even in using fumigants all

exposed surfaces must be washed or sprayed with water. Formalin is commonly used in dairies for disinfecting woodwork, but it must be used in fairly strong solution as it is not very effective against mould spores. Formaldehyde is used in many antiseptic preparations either alone or along with other antiseptics, for example, iodoform, thymol and carbolic acid. Paraformaldehyde slowly gives off formaldehyde and is used in many medical preparations for internal use.

Benzene, toluene, xylene and naphthalene are very mild antiseptics. Naphthalene is used as an insecticide and also, either alone or along with other substances, for example, camphor, in blocks for disinfecting rooms and drains. These blocks are of no use for the disinfection of the atmosphere.

Carbolic acid or phenol is a comparatively weak antiseptic. A 2 to 3 per cent. solution destroys non-sporing germs within five minutes, but even a saturated solution, i.e. a 6 to 7 per cent. solution, may have little effect on spores. It is therefore not suitable for general disinfection. The strength of the aqueous solution is greatly increased by the addition of common salt or hydrochloric acid and decreased by the addition of alcohol. Carbolised oil and vaseline are much weaker antiseptics than the aqueous solution. Pure carbolic acid is a colourless crystalline substance. Its aqueous solution darkens on exposure to light and air, its antiseptic power being slightly increased. Crude carbolic acid is a dark oily liquid containing large quantities of allied substances. Carbolic acid, in 5 per cent. solution, is used in surgery for sterilizing the skin. It can penetrate grease and also to a high degree the substance of the skin, and is not much affected by proteins. Such a solution will not destroy spores and therefore should not be used in the treatment of foul wounds. Carbolic acid is corrosive in nature and therefore should not be used for antiseptic dressings. A 5 per cent. solution is sometimes used in lime wash for disinfecting walls, but a stronger and cheaper disinfectant, for example, lysol or cresol, is preferable.

Carbolates are used in certain disinfecting powders. They react with acids, even carbonic acid, with liberation of carbolic acid, to which their antiseptic properties are due. The composition and antiseptic power of such powders vary greatly. Their antiseptic power is reduced if they are exposed during storage to the atmosphere.

Many other common antiseptics, for example, creosol, cresol, lysol, creosote and tar, are allied chemically to carbolic acid.

The creosote oils and commercial creosote are used for preserving timber. They consist of a mixture of cresols and allied substances. Commercial creosote is a more powerful antiseptic than carbolic acid and is less corrosive. It is practically colourless, but darkens on storage and becomes less powerful. Guaiacol occurs in wood creosote. It is of about the same antiseptic power as carbolic acid. Numerous compounds derived from it are used for medical purposes, some for internal treatment.

Cresol or cresylic acid is twice as powerful an antiseptic as carbolic acid. It is not very soluble in water. The antiseptic power of the aqueous solution is increased by the addition of common salt or hydrochloric acid and decreased by the addition of alcohol. Cresol is largely used in disinfecting preparations, for example, lysol, creolin and tricresol. Lysol consists of cresol and soap. It forms a clear brown, soapy solution in soft water, and owing to the presence of soap acts as a cleansing agent, being able to attack grease. It is a very suitable disinfectant for domestic and farm use. It is twice as powerful as carbolic acid, has much greater penetrating powers, is a cleansing agent, and is cheaper. A 3 to 5 per cent. solution can be used for disinfecting excrements, drains, and for including in lime washes. A 1 to 2 per cent. solution should be used for disinfecting the hands. A 0·5 per cent. solution is suitable as a wash for the hands of milkers and dairy workers. Creolin is somewhat similar in nature and action to lysol. Izal is another useful disinfectant, about eight times as powerful as carbolic acid but much less corrosive. Cyllin is also a powerful disinfectant.

The tars are used for preserving timber, sacking, ropes, &c. Archangel tar is used for treating foot rot in sheep. A special tar can be applied to walls. Walls of cattle sheds may be disinfected by treating the upper portion with lime wash and lysol and the lower portion with tar. Care must be taken in using lysol and other such disinfectants in byres and dairies, otherwise the dairy produce will be tainted.

Benzoic and salicylic acids and their salts are used in many antiseptic preparations, some of which are for internal treatment. They are about five times as powerful as carbolic acid. Benzoic acid and its salts are used as preservatives in certain beverages and condiments. Methyl salicylate is the chief constituent of oil of wintergreen and oil of sweet birch. Phenol salicylate or salol is used in dental and medical preparations and in soaps. It is converted into salicylic acid and carbolic acid by the intestinal juices and is therefore used as an internal antiseptic.

Tannin has little antiseptic action but is used for preserving skins, as it combines with their constituents, forming leather, a material which is not liable to be attacked by germs.

Pyridine and allied substances are responsible for the insecticidal and mild antiseptic properties of tobacco smoke. Nicotine, a powerful insecticide, is present in tobacco juice, but as it is decomposed by heat, little is present in the smoke.

Many of the organic dyes are powerful antiseptics, some being up to 40,000 times as harmful as carbolic acid to certain germs. They may have a marked selective action. Acriflavine is an extremely powerful antiseptic which is very suitable for applying to infected wounds, as it is relatively harmless to animal tissues and is rendered even more powerful in its action on germs by the presence of blood serum.

Turpentine, menthol (oil of peppermint), camphor, eucalyptol (oil of eucalyptus), thymol (oil of thyme), and cinnamon, are

antiseptics frequently used in medical preparations, some of which are for internal treatment; these are also used in dental preparations. Some of them being only slightly soluble in water are used in alcoholic solution or as an emulsion. Camphor is included in disinfecting blocks. These are of no use for aerial disinfection. Terbene, formed by the action of sulphuric acid on turpentine, is used in soaps. The action of turpentine and these allied substances is partly due to their oxidising slowly in air and water with formation of ozone or hydrogen peroxide, both of which are antiseptics. The commercial preparation, Sanitas, contains substances derived from or allied to turpentine and acts in this way.

Some of the spices, for example, cloves, garlic, cinnamon and allspice, have a very slight preserving action, some germs being affected more than others. Mustard and black and white pepper have little or no preserving action.

THE BIOLOGIST on the FARM.—No. XXXIII.

Professor J. Arthur Thomson, M.A., LL.D.,
University of Aberdeen.

Hormones and Sex-Maturity in Pigeons.—Oscar Riddle and Florence Flemion have made experiments on ring-doves by transplanting dove pituitaries and by injecting extracts of bovine pituitaries. The anterior portion of the pituitary appears to produce a hormone which accelerates the attainment of sexual maturity. This has been previously indicated for some other kinds of animals. It is now extended to birds. The effect is most marked in the males. Earlier work has provided some evidence that in ring-doves the bursa Fabricii (a glandular organ associated with the cloaca) and the thymus glands exert a retarding influence on growth and sexual maturity. As the hormone of the anterior pituitary seems to operate in the opposite direction, the actual time of sexual maturity may be regarded as the resultant of two or more opposing influences. Different hormones sometimes act together and sometimes against one another; they are regulators; but the question is arising: *what regulates the regulators?*

Newborn Kangaroos.—We are all familiar with the prococity of the newborn foal, able so soon to stagger along after its mother; and the same is true more or less of many other mammals, especially of those that have nothing in the way of a nest or shelter. The phrase "mare's nest" is proverbial. The contrast between the newborn rabbit and the newborn leveret is well known. The arcs on the trajectory of life have been lengthened out and shortened down in relation to the conditions of everyday life. Thus in quickly moving gregarious animals there is precocity on the part of newborn. They must not be left too far behind the herd. This precocity at birth

usually implies a prolonged gestation, and thus the antenatal period lasts for 9-10 months in cattle, 11 months in horses, 11-13 months in camels, and much longer in elephants, whereas for carnivores it is usually between two and five months, and in rodents and insectivores from three weeks to two months.

It would be easy to get a kangaroo of the same weight as a pony mare, but the former carries its unborn young for about forty days and the latter about eleven months. Moreover, the kangaroo has only a sort of makeshift for a placenta,—a yolk-sac placenta such as is seen as a transitory structure in rodents, insectivores, and bats, before the true allantoic placenta develops. It is not surprising then to find that the newborn kangaroo is less than an inch in length, and it is the contrast between this and the newborn foal that we wish to emphasise. They must be almost the extremes of contrast! The delicate newborn kangaroo, emerging from its mother, obeys an instinctive prompting to clamber upwards through the hair to the external pouch. At this stage, its fore-limbs are actually longer than the legs and the fingers bear tiny claws which help in the climbing. Into the pouch the prematurely born young creature finds its way, unhelped by the mother, and there it gets its mouth over one of the four teats which have become stiff and pointed. When the baby seizes the teat, the tip swells in its mouth—so that the hold is not loosened when the mother jumps about. As Mr. H. C. Raven neatly put it in a recent article, "the young is practically buttoned to its parent, with its mouth representing the button-hole." The young kangaroo is so badly finished at birth that it cannot even suck, and the mother has to inject the milk into its mouth. Some of the milk would be apt to "go down the wrong way" and drown the baby, but this is prevented by another adaptation. The glottis or entrance to the windpipe is shunted forward into the posterior end of the nasal chamber, so that there is a continuous passage for the air from the external nostrils to the lungs. A similar adaptation is seen in whales when they are rushing through the water with their mouth agape, and also in crocodiles when they are drowning their prey by holding it under water. Mr. Raven notes that in the colder parts of Australia the young kangaroos are born about the beginning of winter (April). They remain in the pouch till spring (October). After a period of going out and in, they run about with their mother through their first summer or even longer.

Importance of Good Food.—One does not require to be on a farm or to be a biologist to realise the value of a sound dietary, but some of the details are very interesting, not to say subtle. There is a very common ciliated Infusorian called the Slipper Animalcule or Paramecium, from which biologists have learned much, and there is another common one called Didinium nasutum that is very willing to feed on the former. Mr. C. Dale Beers has made some very neat experiments by nurturing pure lines of Didinium on different diets of starved and well-fed Slipper Animalcules. No limitation was placed on the quantity

of the food; it was entirely a question of quality. The pure lines (all descended from one) which were fed on starved Slipper Animalcules showed a progressive degeneration. This was marked by decrease in their rate of division, by increase in their death-rate, by decrease in the encystment rate and by loss of the ability to encyst, by the production of monstrous, distorted, and dwarfed individuals, by difficulties in ingesting food, and by an end to the lineage after 20-40 days. The lines that were nurtured on well-fed Slipper Animalcules continued with undiminished vigour throughout the experiment, and showed no hint of degeneration. This is important, for it bears out what other workers had begun to suspect, that the cyclical setting in of "depression" and degeneracy, which had been ascribed to an inherent trend towards senescence, may be due to inadequacy of diet. It is obviously a far cry from Infusorians to farm stock, but there is a unity in life, and Beers' experiments yield two general conclusions. First, the influences of adequate or of deficient dietary are subtle and far-reaching. Second, we must be careful not to ascribe to ageing, or to inbreeding, or to a tendency to regression, or to *any* intrinsic cause, observed degenerative changes that may be wholly due to defective diet.

The Menace of Ants to Vegetation.—In the eastern United States there is a common mound-building ant, Formica exsectoides, which is blamed for killing trees. This accusation has been recently investigated by Professor E. A. Andrews of Johns Hopkins University, who finds, as usual, that the issues are very complex. In the first place, the ant in question is not a vegetarian, and any harm it does is not from eating leaves or wood. Nor does it make tunnels in the stems or branches. On the other hand, there is a notable dying away of the trees in the vicinity of the mounds, which are often about three feet in height and six feet in diameter. The ants search the trees for insects and for the honeydew produced by Aphids, scaly-bugs, and tree hoppers. They certainly kill some small creatures that injure leaves, but they also defend insects which tap the juices of the plants and make honeydew. But again in removing the honeydew they keep many leaves from being smothered. It is obviously difficult to balance the pro's and con's.

After taking evidence in a fair-minded way, Andrews comes to the conclusion that in Maryland and elsewhere the mound-building ants do actually kill small trees and other plants, especially in young plantations. They destroy leaves and growing tips by nibbling them, but they do not eat the vegetable-tissue. There may be an advantage in doing this, for the nibbling checks growth and may keep the adjacent trees from rapidly overshadowing the mounds. The ants require exposure to the sunshine, hence the advantage of a clearing. Eventually, of course, the forest may prove stronger than the ants, and lead to an abandonment of the mounds. Against the harm done by sheltering certain injurious insects we must set the fact that the ants kill other insects also injurious, and that they remove the honeydew.

One cannot suppose that the ants deliberately nibble the trees in order to keep their mounds from being shaded. Andrews thinks that the custom of attacking the trees may prove to be "of the nature of instinctive action rather misdirected by unusual internal factors, yet becoming of use to the race." The moral is that we should not be in a hurry to get a simple clear-cut verdict for or against an animal—whether bird or beast. The issues are usually intricate.

Simian Sympathy.—It is a little difficult to bring monkeys within the range of the biologist on the farm, but we might recall the way in which a simian of the Far East is trained to climb the Coco-palms and gather the nuts, selecting those that are ripe. This is certainly working on the farm! But the truth of the matter is that we wish to pass on a good instance of simian sympathy, which has been communicated to us by that veteran observer Professor Sir Flinders Petrie, who has kindly allowed us to use the incident. We value this privilege the more since the facts come from one accustomed all his life to be precise. He had trapped his finger in a door and it was swollen and painful with black nail. When he went to see a monkey which he visited daily, he offered only the uninjured hand. The monkey looked anxiously for the other and was excited when he saw it. "He took it most gently, and sampled the fingers all round with light touches to see where it was hurt, and how tense it was. Every day he expected to examine it, as delicately as any surgeon could, and this diagnosis went on till it was well." Such is simian sympathy, and the instance is in a line with the careful and critical study of chimpanzees by Professor Köhler, who found very distinct evidence of their sympathetic feeling towards man. They liked to be on friendly relations; their feelings were wounded by punishment; they enjoyed restoration to favour; they took the side of their master against human intruders. The moral is to cultivate sympathetic relations with the higher domesticated animals, such as horse and dog, for we shall by no means lose our reward.

The Sense of Direction Again.—We have been re-reading Rabaud's book on orientation: *How Animals Find Their Way About* (Kegan Paul, 1928); and the strong impression is left in our mind that the assumption of a special sense of direction is for many cases no longer tenable. Apart from a few very puzzling cases, it looks as if the homing of ants, bees, and wasps could be satisfactorily described in terms of the apprenticeship which these well-endowed insects serve to finding their way about their district. Bees transported a couple of miles inland will rapidly return to the hive, but none come back if they are transported for half that distance out on a lake, of which of course they have had no experience, and where, in any case, they could find no landmarks or finger-posts on which to base associations. According to Rabaud, the orientation of bees brings into play sensory cues only, including perhaps some registration of muscular movements performed. Careful experiments on bees show that the

long-distance cues are mainly visual, but they are relations between objects rather than the objects themselves, as is shown by the way the creatures are nonplussed when they come back to where the hive—only slightly shifted—should be but isn't. Among ants use is made of olfactory and tactile, as well as visual clews, but Rabaud concludes that "the return to the nest in no way leads us to assume the existence of any unknown sense which would merit the name of sense of orientation."

Carrier pigeons show extraordinary educability in "homing," which is the more remarkable since the ancestral Rock Dove is a more or less resident bird; but the chief factor seems to be the graduated apprenticeship. Rabaud emphasises the significant fact that on occasions which present some difficulty, such as traversing an entirely new tract of country, the carriers take far too long. Thus eight of them took thirteen hours for a new journey from London to Antwerp, which should not have required more than three. The same fact was noted by Watson and Lashley in regard to those transported terns which succeeded in returning to the Tortugas from waters far to the north of their migratory range. The time taken was enough to allow for many tentatives and many mistakes. In regard to the homing of ordinary migratory birds there are great difficulties. Thus the young birds, quite inexperienced, often make the journey alone, to an unknown goal, and across the pathless sea. The return route in spring is often different from that taken in autumn. It is difficult to suggest what stimuli the migrants are receiving, and while some of those who know most about the migration of birds are inclined to postulate a hereditary memory of direction, it is difficult to invest that memory with any objective content. There is need for more experimenting with migratory birds to discover whether the postulate of a sense of direction can be dispensed with, as seems to be the case with most of the homing achievements of ants, bees, and wasps. It is not unlikely that some very useful result would reward any one with leisure, patience, and a thoroughly sceptical mind, who would begin with mastering Rabaud's excellent book, and then proceed to test experimentally the more or less flabby evidence of homing in mammals, such as cats and dogs.

The Foula Mouse.—We have been much interested lately in specimens of a peculiar mouse which one of our students was kind enough to send us from Foula, a rocky island in the Atlantic, about 16 miles from the nearest point of the mainland of Shetland. On the rough tussocky ground that extends from sea level to a height of 1,000 feet, the peculiar "Hill Mice" have their home, and they are found nowhere else. They afford an interesting illustration of evolution going on, for it looks as if a new species was a-making under our eyes.

Perhaps the commonest mammal in Europe is the Long-tailed Field Mouse, which used to be called Mus sylvaticus, but is now called Apodemus sylvaticus. It occurs all over Britain, and it has relatives, which are almost certainly its descendants.

There is the Hebridean Field Mouse, of which there are four or five geographical varieties; there is the St. Kilda Field Mouse; there is the Fair Isle Field Mouse, Apodemus fridariensis; and some would add a fifth British species, the southern Yellow-necked Field Mouse, Apodemus flavicollis. Now where does the Foula Mouse come in? The almost certain answer is that its origin is to be looked for in the Fair Isle species, which in turn sprang from the common Long-tailed Field Mouse. If we suppose that a few individuals of the Fair Isle species found their way on a fishing smack to Foula; that they bred and flourished; and that they gave rise to new departures or variations as many kinds of animals are wont to do. But when variations arise in conditions of insulation, where there is bound to be inbreeding among similars, there is an increased likelihood of the new departure becoming stable and permanent. So with the Orkney Vole and the St. Kilda wren. The Foula Mouse is called by the experts Apodemus fridariensis thuleo, and from being a very distinct variety it may gradually diverge into a distinct species. Evolution is going on.

THE following article is contributed by Mr. E. Whittaker, B.Sc., Agricultural Economist, Edinburgh and East of Scotland College of Agriculture.

The proportion of the population engaged in agriculture has become, throughout history, steadily smaller.

Population and Rewards in Agriculture.

The people of long ago were all farmers. They had to farm in order that they might live. Food was necessary, and our ancestors were inefficient in its production. Each farm family produced but little beyond its own needs. There was no surplus to exchange for other things, and, therefore, with the exception of the barest minima of clothing and shelter, the family had to do without any other things.

The passage of time, however, has brought a change in this state of affairs. One improvement after another has been made in the implements and methods of agriculture. Breeds of live stock have been developed which grow larger and fatten more quickly than did their ancient prototypes. Fertilisers, mined at the ends of the earth, or manufactured by the skill of chemists from what, hitherto, had been regarded as useless waste-products, have come into use. New machines have made it possible for the farm worker of to-day to do what was, seemingly but yesterday, the work of two or three men. Better methods, the results of the patient experiments of agricultural pioneers, have been adopted.

The extension of agriculture into newer and more fertile fields abroad has enabled agriculturists to apply their efforts to better soil. Wild glens in the Highlands have gone out of cuti-vation, stony hillsides in New England have been abandoned for the fertile plains of Missouri and Argentina. The fact that

"Nature" is doing more in agricultural production makes it possible for "Labour" to do less.

Thus, statistics quoted by H. C. Taylor in his work on "Agricultural Economics" show that, whilst in 1829-30 3·2 hours of man-labour were required to produce one bushel of wheat, in 1920 0·9 hours in Nebraska, and 0·3 hours only in Oregon, gave the same production.

The exertions of a single farmer are becoming more and more productive, and are feeding an increasing number of people.

Man's requirements for food are limited. In fact it seems probable that the worker of to-day, increasingly engaged in superintending the operation of machines rather than in exercising his muscles, actually consumes a smaller quantity, though no doubt a better quality, of food than did his ancestor of long ago. The food is eaten in a more elaborate form. The elaboration of it provides occupation for a greater number of cooks and bakers than there used to be, but makes no increased call on the services of the farmer.

If the individual man's consumption of food is limited, then every improvement in the arts of food production will make it possible for the sustenance requirements of the world to be met by a smaller proportion of its population. More and more of the people can be spared from the labour of food production to engage in other things, and agriculture must, we conclude, so long as progress goes on, continue to absorb a diminishing percentage of the total occupied population. A stream of people will flow, as the years pass by, from the farms of the world into urban industry.

The movement of workers from agriculture which results from progress is added to by another, and quite different, cause. Even if there were no progress in the arts of agriculture, and a constant proportion of the world's people were needed to furnish its food supply, a stream of people would have to leave the land because the rural population increases more rapidly than does that of the towns. Almost universally the birth-rate is higher and the death-rate lower in the country than in urban communities. Farm workers have larger families, and live longer, than do members of the same society living in towns.

The following figures from the Registrar-General's Decennial Supplement, England and Wales, 1921, illustrate this :—

Mortality (1921-23) *of Males aged* 20-65 (*working ages*) *in each Occupation.*

	No. of males aged 20–65. (1921 Census.)	No. of deaths registered.	No. of deaths registered per 1000 males aged 20–65.
All occupied and retired males .	9,704,860	266,384	27·45
Farmers	218,494	5,605	25·65
Agricultural labourers, farm servants	383,165	7,748	20·22

If the differences in the age distribution of people in the above groups are taken into account, and regard is had to the normal expectation of life of people of different ages, agriculture is seen in an even better light. The ratio in which deaths occur then becomes amongst farmers 71 and farm labourers 69, as compared with 100 for "all occupied and retired males."

The birth-rate statistics, similarly, show that in agriculture there is a tendency in favour of more rapid increase than in other occupations. Thus :—

Legitimate Fertility, 1921.

	No. of married males under 55 years of age.	Registered legitimate births.	Infant mortality per 1000 births.	Registered births less infantile deaths, per 1000 married males under 55 years of age.
All males	5,802,922	810,196	79	128·5
Farmers	125,215	16,878	50	128·0
Agricultural labourers, farm servants	176,572	27,315	68	144·2

Again, if allowances were made for differences in ages in the three groups, a still higher rate of fertility would be shown, i.e. amongst farmers 123 and farm labourers 111, as against 100 for "all males." Probably, however, the figures given above, representing the actual fertility, are better for the present purpose.

Further, the above figures take account only of legitimate births. The number of illegitimate births amongst women engaged in agricultural occupations is considerably higher than that for the general population, but their inclusion would not affect to any considerable extent the statistics given.

More people are born, evidently, and fewer die in farming than in other pursuits, and it should be noted that, if a comparison is made between the different classes of agriculturists, the farm servants are shown to multiply more rapidly than do the farmers.

Plainly, then, two causes, the progress of agriculture itself and the tendency for its people to multiply with greater rapidity than do other sections of the community, contribute to a flow of workers from the land to the towns.

The extent of this movement is indicated to some extent by the following figures :—

Proportion of Rural Population to Total Population. *Per cent.*

	1881.	*1891.*	*1901.*	*1911.*	*1921.*
England and Wales ...	32·0	28·0	23·0	22·0	20·5
Canada	. .	68·0	63·5	54·5	50·5
	1880.	*1890.*	*1900.*	*1910.*	*1920.*
United States	71·5	64·5	60·0	54·0	48·5
Sweden	67·5	61·5	54·5	48·5	...

Such statistics are available only for the period which has elapsed since the census was instituted in the different countries. Further, they should be interpreted with great caution, since part of the movement of country people into the city revealed by census figures represents an extension of the principle of division of labour, and a tendency for what, hitherto, have been village industries to be attracted to more populous centres. At the time of the Domesday survey, the farmer cut, shaped, and stitched his rude footwear. Similarly, his wife span the coarse thread from which his clothes were made. By and by such tasks came to be undertaken by craftsmen in the village, sons and brothers of the farm workers, who exchanged their manufactures for the surplus food made available by the farmers devoting their whole time to food production. History has shown a tendency for village crafts to migrate to the towns, and modern transport and power developments have accelerated this movement.

The country population has been reduced, also, by migration to the towns of the workers responsible for the elaboration of food products. No longer does every village contain its mill. Huge plants grind into flour the wheat produced by a whole countryside. Slaughtering and bacon-curing have migrated also. Less and less are food products elaborated by the farm worker or the villager, more and more are they sent in a crude form to be worked up in the towns. Modern developments are not, of course, all in one direction, and there are many instances of new industries being planted, as a result of hydro-electric power or railway extension, in what are accepted statistically as predominantly rural areas.

However, making allowance for these changes, there can be no doubt but that a movement of labour from the land to the towns does exist, has existed all through the ages, and seemingly will exist so long as agriculture becomes more efficient, and so long as its people persist in multiplying with greater rapidity than do the rest of the community.

Having admitted that a gradual flow of labour from agriculture into industry is inevitable, the economist must investigate its effects.

If there is a tendency for the supply of labour in farming to be perpetually in excess of requirements, then, because there is too much of it, such labour will command a reward that is lower than is obtainable in other pursuits. In so far as there tend to be too many farmers, the profits of the farmer will be low. If the farm labourers multiply more rapidly still, then they can be expected, because of this, to occupy a position even less advantageous.

If workers could move with perfect freedom between agriculture and industry, then difference in rewards would be very slight, because, immediately the workers became conscious of such a difference, the surplus people would migrate to the employments where their labour commanded a better price.

There is, of course, no such complete mobility. If effort and

skill in one or other kind of town industry should become more highly paid than is the labour of the agriculturist, the countryman—his skill being "tied up," as it were, in agricultural knowledge—can move to the town, if at all, only with very great difficulty.

Agriculture, like coal mining, is carried on in areas which are often isolated from other industrial activities. In consequence, the movement of surplus labour from the land into other spheres of utility presents a serious problem, although it must be admitted that recent improvements in rural transport are mitigating its seriousness.

It is necessary for the children of the agricultural worker to enter employment at an early age, and, if farming is the only occupation open to them, into it they must go.

The migration of village industries to the towns has taken them beyond the ken of the countryman, and made it more difficult for his children to enter occupations other than farming in their youth.

Further, the disappearance of the horse from city streets has closed one avenue by which the adult landworker was able to make an entry into town life.

Since there are barriers hindering his entry into urban industry, the surplus worker of the countryside often moves overseas, there to compete more effectively with his fellows at home. Sentimental reasons, however, make the average worker prefer to remain in the homeland, even when he knows, or thinks, that he might be better off abroad.

Because of difficulties hindering free movement into industry, the surplus labour constantly arising in agriculture tends to stay there. Too many people remain in farming, and, by their competition, cause the rewards accruing as a result of their toil—the farmer's profits and the farm servant's wages—to be low. The surplus is "squeezed out" ultimately—we followed through statistical data the process of "squeezing out" in countries with very different conditions—but the fact that the "squeezing out" process is impeded by barriers, and goes on with consequent difficulty, makes for a standard of life in agriculture which is definitely lower than obtains in other pursuits.

How far is this expectation borne out in fact?

The position of the farmer, as compared with that of his fellow business-man in industry, is difficult to assess satisfactorily. Pre-war estimates of income in the United States placed the share of agriculture at 18 per cent. of the total, notwithstanding that 32·6 per cent. of all the people over ten years of age and engaged in gainful occupations worked in agriculture, and that 27 per cent. of the total national capital was employed there. Rental values of farmhouses were omitted, but even so the agriculturist reaped a reward which was small in relation to his contributions of capital and labour.

More reliable figures are available as to wage rates, and the

position of the wage earner in farming is seen to compare very unfavourably with that of the town worker.

Thus the Nineteenth Abstract of Labour Statistics for the United Kingdom shows that in July 1914 the average rate of wages paid to ordinary male agricultural labourers in England and Wales (including the value of certain allowances in kind) was computed to be 18*s*. per week. Wages in the other occupations listed ranged from 19*s*. 2*d*. for railway passenger porters to 41*s*. 4*d*. for shipwrights.

The war and post-war period brought a general increase in wage rates. This increase was by no means uniformly distributed, but the most recent figures—those for December 31st, 1927—show agriculture, with an average weekly wage of 31*s*. 8*d*., still in the lowest position, the other occupations varying from 38*s*. 5*d*. for shipbuilding labourers to 75*s*. 8*d*. for plasterers.

The variation in wage rates is, of course, intimately connected with the incidence of unemployment in the different industries, but the problems involved in this relation are too wide for discussion here.

Evidently, whatever be the cause of the difference, the agriculturist is rewarded at a lower rate than is his fellow worker in industry.

It is not intended, of course, to suggest that the whole explanation of this difference in rewards is to be found in the factors we have examined, but that they have a contributory influence, lasting in nature, seems not to be doubted.

Egg Production in Tiree and Uist.

ATTENTION has frequently been directed to the important part which poultry play in the economic position of the small-holder, but few figures are available to show the monetary returns holders receive from the sale of eggs in any given area.

It is a matter of extreme difficulty, so far as the greater part of Scotland is concerned, to isolate a county or part of a county and to ascertain with any degree of accuracy the egg production in the selected area.

In the following notes, contributed by Mr. Alexander F. Smith, egg marketing officer to the Department of Agriculture for Scotland, an attempt has been made to ascertain the egg production and exports of two areas, Tiree and Uist. In both of these areas a considerable amount of attention has been given to poultry keeping, but there is, it is believed, ample room for the development of egg production.

The figures given below for exports are definitely accurate, facilities having been granted to abstract this information from the shipping companies' or piermasters' books.

Tiree—The Island of Tiree is dry and sandy and appears well suited for poultry keeping, although the lack of shelter is

a disadvantage. At one time five agricultural co-operative societies were in existence and were actively engaged in disposing of the eggs produced on their members' holdings. Three of these societies have become defunct and one of the remaining two societies does little business. Eggs are chiefly sold to local merchants and are either brought in to the local shops or collected by vans delivering groceries. The usual market for eggs from Tiree is Glasgow or Oban, to both of which centres there is a reasonably good steamer service.

The local population is almost entirely engaged in agriculture, and almost all the land is divided into small holdings. The only other industries besides agriculture are lobster fishing, herring curing to a small extent, and kelp burning. The population according to the last census in 1921 totalled 1,716. This is largely augmented during the summer months when the island is visited by a large number of holiday-makers; it is estimated locally that during July and August the influx of visitors is not less than 1,000, and this number could probably be considerably increased were more accommodation available.

The aggregate number of eggs consumed and taken away by such visitors may be taken as not less than 5,100 dozen. The number of eggs consumed by the resident population cannot be definitely stated, but from local enquiry it may be safely estimated that the number is not less than 21 dozen per annum per head of the population. This number is considerably in excess of the consumption in industrial centres, but there is a greater incentive to use home produce when the price is considerably below that of bought foodstuffs.

Taking the local consumption at 21 dozen per head per annum and assuming the population to be the same as in 1921, then the total number of eggs consumed by the resident population would be in round figures 36,000 dozen.

In regard to exports, definite figures are available. During the period 1st April 1927 to 31st March 1928 the export of eggs totalled 45,900 dozen.

From the above figures it is possible to arrive at a reasonably accurate estimate of the total production for the island.

Consumed by resident population ...	36,000	dozen.
Consumed by visitors	5,100	,,
Exported	45,900	,,
	87,000	dozen.

Taking the average price for the year at the reasonable figure of 1*s*. 4*d*. per dozen, then the total value of the egg production of Tiree would work out at £5,800, of which sum exports represent £3,060.

According to the valuation figures, the gross valuation of Tiree is £4,887, so that the value of eggs produced in the island is roughly 19 per cent. in excess of the total valuation, or 50

per cent. in excess of the agricultural valuation, which amounts to £3,850.

Uist and Benbecula.—The islands of South Uist, Benbecula and North Uist are purely crofting districts. Agriculture is the sole industry with the exception of lobster fishing, herring curing to some extent at Loch Boisdale, kelp burning, and some hand-loom weaving. The arable area forms a strip of varying width along the western seaboard and consists mostly of sandy land with peat in certain areas.

The number of products which are available for export are distinctly limited, and it is therefore of the highest importance to increase as far as possible the few products which the islands can export.

The potentialities of egg production as a source of income to the crofters in these islands are considerable and have to some extent been realised. Twenty years ago the value of poultry was little appreciated or understood. Prices paid for eggs were low, and as a result little interest was taken in the rearing, housing and feeding of poultry or in the selection of stock. Since that time things have altered. Societies formed for the purpose of selling the eggs of their members were successful in securing enhanced prices and this stimulated interest in the poultry industry, an interest reflected in the demands made for expert advice from the local instructress in poultry-keeping.

Shops are numerous and eggs are either delivered to the shop by the producers or collected by motor vans engaged in delivering groceries. Several co-operative societies are in existence and may be regarded as having reached an age and degree of strength which suggest their continuance.

Eggs are exported chiefly to Glasgow and Oban, and also to Mallaig and Kyle of Lochalsh. Freight charges are heavy and amount to over one penny per dozen eggs.

The total production of eggs is calculated on the same basis as that adopted in the case of Tiree. Local enquiry suggests that the quantity of eggs consumed per head of the population per annum may be taken as 21 dozen, but this figure may be regarded as an under-estimate rather than an over-estimate. The census return for 1921 showed the population of the area to be 7,640. This excludes the island of Eriskay, which is not included in the export figures. Since 1921 there has been a considerable reduction in population due to emigration. Assuming the reduction to be 240, then the population would be 7,400, and on the basis of 21 dozen eggs consumed per head the local consumption would be 155,400 dozen. In addition to the consumption by the resident population, there is a certain number of eggs consumed in hotels, shooting lodges, &c. If this is taken at 600 dozen per annum, the local consumption totals 156,000 dozen.

Exports go from the following ports :—South Boisdale, Loch Boisdale, Loch Skipport, Loch Carnan, Petersport, Kallin, Scotvin, Locheport and Lochmaddy.

The export figures month by month for the period 1st April 1927 to 31st March 1928 are as follows :—

April	26,820 dozen.
May	30,510 ,,
June	23,430 ,,
July	20,580 ,,
August	16,290 ,,
September	10,920 ,,
October	6,840 ,,
November	2,850 ,,
December	1,470 ,,
January	2,850 ,,
February	6,420 ,,
March	16,740 ,,
	165,720 ,,

In addition to these exports eggs are taken for use in the ships regularly calling at the various ports. This figure is estimated at 280 dozen, and increases the total exports to 166,000 dozen. The total production would therefore be :—

Consumed in the islands	156,000 dozen.
Exported from the islands ...	166,000 ,,
Total	322,000 dozen.

Making the average price 1*s.* 3*d.* per dozen, the value of the eggs produced would total £20,125, of which sum exports represent £10,375.

According to the most recent valuation roll the gross value of the area amounted to £7,935 and the agricultural valuation to £6,767. From this it would appear that the value of the egg production of Uist is roughly two and a half times the gross valuation of the area, while the value of the eggs exported is £2,440 more than the gross valuation, and £3,608 more than the agricultural valuation.

A significant feature of the monthly export figures is the smallness of the exports during November, December and January, the total for these three months being only 4·3 per cent. of the total export. As these are the months when the best prices are obtainable, an effort should be made to increase production during this period.

The reputation of West Highland eggs is not as high as it might or should be. Better housing and management of the poultry and more efficient methods of handling must be adopted if these eggs are to compete successfully with supplies from other areas. They must not only be clean, fresh and of reasonable size, but they must be packed in suitable cases, with clean fillers and flats, or wood wool, if they are to attract buyers.

Attention to these points would amply repay the packer and would lead to increased prices. Enhanced prices result in

increased production. Increased production and export mean lower freights. To the struggling crofters in those Western Isles the development of poultry-keeping offers a return at least equal to that which they can obtain in any other way and would assist in bringing prosperity to the inhabitants.

Craibstone.

Notes from Agricultural Colleges.

Experiments with Oats, 1928.—A very important problem at the present time is the difficulty of getting oats to stand, especially on lea after wild white clover. This tendency to lodge has been accentuated, however, during the last few years by the fact that there have been spells of very rapid growth which weakened the stalks and rendered them unfit to stand up against the subsequent heavy rains.

There were no oats after lea at Craibstone in 1928, a potato crop being taken instead, but in trials after roots heavy dressings of nitrogenous manures were applied so as to produce as nearly as possible the conditions met with after lea.

In one such trial after potatoes, with varieties which in previous years stood up well, there was no lodging, although in all cases the crops were good. The following table gives the yield of grain and straw.

Sown 4th April.	Ripe.	Per Acre.	
		Weight of Grain.	Weight of Straw.
		cwt.	cwt.
Banner Tartary 9	22nd Sept.	29·4	33·0
Beseler's Prolific	Do.	30·4	35·7
Marsholt	Do.	30·6	31·5
Marvellous	10th Sept.	30·1	28·6
New Number	4th Oct.	28·9	33·0
Record	22nd Sept.	30·0	33·7
Superb	13th ,,	29·2	30·1
Upright	19th ,,	30·7	33·0
Victory	22nd ,,	34·1	31·9
Yielder	13th ,,	31·6	35·7

Several varieties of oats with a reputation for good standing power were obtained from America in the hope that some of them might be useful here. These were sown alongside Abundance and Yielder for comparison. Both of these stood well. Several of the varieties—Albion, Gopher, Iogold, States Pride and White Cross—were very early, about three weeks earlier than Yielder; but the yields in every case were much less. The first two were very short in the straw and stood, while the other three were slightly laid. Colorado 37 and Wisconsin Wonder both stood, but were about a week later than Yielder. The latter, however, gave a heavier yield. Other late varieties, Lee and

Minota, were very badly laid, while Markton was slightly laid. Idamine, which produced a heavier crop than Yielder and was about equal in earliness, was only slightly leaning. The best of these are sown this year after lea.

In previous years, trials with Potato and Victory Oats sown at weekly intervals from 1st March onwards have shown that the early sowings not only stood better but also produced heavier yields of both grain and straw, there having been an average reduction of about ¼ cwt. per day when sowing was delayed beyond the end of March if the soil was in a condition for sowing. In 1928, however, while there was a gradual reduction in yield after mid-April, sowings in the first half of the month were quite as good as those sown earlier. This result is probably due to the fact that there was a sufficient amount of moisture during the whole of the growing season. Usually there is a dry period during June, and the late sown always suffer more than the early sown oats.

So far as standing power is concerned, the results of previous years were fully borne out. In the case of Potato, all the plots were laid, but the early sowings were the last to lodge and were in quite good condition. With Victory, all the March-sown plots remained standing, whereas all the later sown plots were laid. In addition, the early-sown plots ripened earlier. For example, the plot sown on 22nd March was ripe a fortnight earlier than that sown on 19th April. Also, the grain produced on the early plots was a much better sample, there being many greens in the late sown plots.

In a plot seeded with fully 2½ cwt. per acre of an ungraded sample of Victory Oats, the stalks were very irregular in growth and the plot was laid, whereas in another plot alongside, where the small grains weighing fully ½ cwt. were sifted out and the remaining two cwt. of uniformly-sized grain sown, the stalks were longer, much more uniform in size, the ears were larger and the plot was standing when the grain was ripe. Not only so, but the graded sample, as in previous trials, produced fully a heavier yield.

It is interesting to note that a sample of Victory obtained from a very light soil contained a considerable proportion of Wild Oats. The sample was graded and the large and small seeds sown separately. It was found that the Wild Oats were confined almost entirely to the small seed plot. Wild Oats can therefore be controlled by efficient grading.

Some interest was aroused lately in the popular press by what is described as a Chinese method of cultivating oats by transplanting. In the beginning of May a number of seedlings of Potato and Victory Oats from the early sown plots were planted 12 in. apart each way. The plants grew strongly and tillered out well, especially the Potato, some plants of which produced as many as 15 to 20 stalks. The crop, however, was far too late ever to come to maturity under our conditions, and the ripening was most irregular.

Kilmarnock.

Types and Varieties of Turnips and Swedes.—For the past four seasons trials have been conducted at Kilmarnock with a view to determining the relative merits of the different types of turnips and swedes commonly grown. There was great need for such a trial, for while named varieties are very numerous, the actual number of distinct types is not nearly so great.

In all, twelve varieties of turnips and thirteen varieties of swedes representing distinct types have been compared, and in so far as possible varieties fairly widely grown in the south-west of Scotland and representative of the different types were selected. The following table gives the average yields per acre for the four years 1925 to 1928 inclusive; the percentages of dry matter and the total dry matter per acre.

Variety.	Average for Four Seasons.		Dry Matter.	Dry Matter per acre.
	tons	cwts	per cent.	cwts.
WHITE TURNIPS.				
Red Globe	23	7¼	7·75	36·2
White Globe	25	0½	7·18	36·0
Purple Top Mammoth...	27	7½	7·67	42·0
Green Top White	24	3¾	7·85	38·0
Greystone	24	0	7·55	36·2
YELLOW TURNIPS.				
(a) (*Flesh, Pale Yellow.*)				
Centenary Green Top Yellow... ...	23	13¼	7·89	37·3
Fosterton Hybrid	24	10¼	8·39	41·1
Green Top Yellow Tankard	21	14½	8·02	34·8
(b) (*Flesh, Yellow.*)				
Early Sheepfold	20	15¼	8·51	35·3
Purple Top Yellow	21	15¼	8·82	38·4
Aberdeen Green Top Golden	20	12¾	8·81	36·3
Aberdeen Green Top Bullock... ...	22	16¾	8·33	38·0
SWEDES.				
(a) (*Purple Top.*)				
Best of all	25	0	10·94	54·7
Picton	31	13	10·62	67·2
Knockdon	29	15¾	10·11	60·1
Dwarf Purple Top	30	8¾	10·88	66 1
Elephant	27	10½	11·03	60·7
Skirving	23	17½	11·77	55·2
Springwood	22	12½	11·59	52·4
Enterkin	23	1½	10·18	47·0
(b) (*Bronze Top.*)				
X.L. All	26	17¾	10·65	57·3
Scotia	28	6¾	10·70	60·6
Conqueror	26	8¼	10·80	57·0
Halewood	26	10	11·04	58·5
(c) (*Green Top.*)				
Green Top	25	14¾	10·30	53·0

In the above table the varieties included in the trial are arranged very much in their order of maturing, commencing

with Red Globe, the earliest of the white fleshed turnips, and ending with the Green Top swede, which takes longer to mature than any of the other types.

The following notes indicate the characteristics of each variety.

White Turnips (flesh white).

Red Globe.—Skin colour and shape are as indicated by name, but many bulbs are somewhat cylindrical and fanging is common. An early maturing very soft variety; generally ready for feeding early in September; a moderate cropper, but does not stand frost and rots readily.

White Globe.—Round to globular shape, skin colour white. Reaches maturity early in the season and does not stand the frost. The crown is frequently concave and furrowed, and tends to hold the moisture with consequent damage to the bulb. This variety is very susceptible to wet rot.

Purple Top Mammoth.—Semi-tankard or oval in shape. Skin colour a deep purple. Bulbs of this variety attain to a very large size but are often hollow in the centre. It matures almost as early as the White Globe, is normally a large cropper, but does not stand frost.

Green Top White.—Semi-globular in shape with a fairly high crown. Skin colour a pale green. A heavy cropping type and much hardier than the foregoing varieties, but not suitable for long keeping.

Greystone.—Globular to oblong in shape. Skin colour mottled purple and green. This variety does not crop so well as most of the foregoing, but is rather hardier and more resistant to disease. The flesh is of poor feeding value.

Yellow Turnips (a) (Pale yellow flesh).

Centenary (Sutton).—Globe-shaped bulb. Skin colour green, with a distinctly russeted appearance. Flesh rather soft but of fairly good quality. Bulbs generally very uniform in size and shape; crops well but must not be sown too early. Moderately hardy and can be used until about Christmas.

Fosterton Hybrid.—Oblong to globular in shape, bulb with a russety green skin colour. Flesh rather soft. This variety, which has distinctly curled leaves, stands well out of the ground and is very useful for eating off with sheep. This is the heaviest cropping yellow turnip, but does not keep well unless lifted and clamped before being touched by frost; if this is done it will keep until about February.

Green Top Yellow Tankard.—This variety is little grown in Scotland. The colour of skin and shape of bulb are as

indicated in the name. Some bulbs are very long, the part above ground being frequently 12 ins. to 15 ins. in height, and on that account it is in favour for sheep folding and widely grown in some parts of England for that purpose. It is a variety capable of yielding a large crop because of the closer singling that may be adopted, but it is rather susceptible to the ravages of finger-and-toe disease.

Yellow Turnips. (*b*) (Yellow flesh.)

Early Sheepfold (Sutton).—Bulb semi-globular in shape. Skin colour a bright green above ground and a rich deep yellow below. An early maturing form of the Aberdeen Green Top and a heavy cropper, but the bulbs crack readily. It is not so hardy and does not keep so well.

Purple Top Yellow.—Bulb globular to oval in shape with a bright purple skin and strong foliage. Flesh moderately firm. A good cropper, an excellent keeper and widely grown.

Aberdeen Green Top Golden.—Globular in shape, with the skin colour deep green above the ground line and bright orange below. The flesh is solid, but the yield per acre is rather low.

Aberdeen Green Top Yellow Bullock.—Bulb semi-globular in shape with a bright green skin colour above ground. A hardy variety, and if lifted and clamped or ploughed in will keep well into the spring. Many lowland sheep farmers prefer it for the ewes in March and April. A firm fleshed, good cropping variety and widely grown.

Swedes. (*a*) (Purple topped.)

Best of All.—Typical bulbs are globe-shaped with a reddish purple skin colour. One of the most widely grown varieties and largely sold under trade proprietary names, e.g. Magnum Bonum, Eclipse, Magnificent, Paragon, &c. Has been largely used for selection and crossing. The flesh is open and soft, and varieties of this type are rather subject to disease, e.g. dry rot.

Picton.—The result of a cross between Knockdon and Monarch. Bulbs, semi-tankard in shape and with a bright pinkish purple colour. A swede with very palatable flesh, and specially suitable for shopping purposes. The heaviest cropping of the varieties tested at Kilmarnock, it is hardy and keeps well.

Knockdon.—A selection from Best of All but now quite distinct. Bulb semi-tankard with a pinkish purple skin colour and the shoulder more fully rounded than in Picton. This variety has very palatable flesh. It stands well out

of the ground and is a good cropper, but is rather subject to dry rot.

Dwarf Purple Top.—Bulb globe-shaped and the skin colour a dark purple. A very heavy cropping variety and suitable for the vegetable trade.

Elephant.—Bulb tankard shaped and usually plum coloured. This type shows marked variations of skin colour ranging from light purple to plum. Bulbs stand well out of the ground, but the flesh is rather open in texture, and though a bulky cropper it is generally inferior in weight.

Skirving.—Bulb semi-globular in shape with a bronze purple skin colour. One of the oldest varieties in cultivation, but now largely discarded in favour of some of the newer and heavier cropping types. Stands well out of the ground but has rather a long neck. The flesh of this swede though solid is not particularly palatable. Further, this variety suffers readily from the ravages of finger-and-toe.

Springwood.—Bulb semi-tankard in shape. Skin colour between purple and bronze, neck a little too strong. Matures rather slowly and is only a moderate cropper.

Enterkin.—Semi-globular in shape with nicely rounded shoulder. Skin rough, russety and tinged with bronze. Slow maturing but very hardy, and can be left growing until required in spring, except in the more exposed places. Only a moderate cropper.

(*b*) (Bronze topped.)

X.L. All.—Bulb, semi-globular or oval in shape. Skin colour a purplish bronze. Flesh fairly solid. A hardy, heavy-cropping variety specially suitable for shopping purposes, and very popular in the south-west of Scotland.

Scotia.—Bulb tankard shaped and shows great uniformity in type. Skin colour bronze. This swede matures slowly but has very firm flesh and is one of the best cropping varieties. Last season this variety suffered to some extent from dry rot.

Hakewood.—Bulb tankard to semi-globular in shape. Skin colour greenish bronze. A slow maturing variety. Very hardy and a long keeper.

Conqueror.—Bulb globe-shaped. Skin colour greenish bronze. Slow in reaching maturity, but a fair cropper with solid flesh, and a long keeper. Fairly resistant to finger-and-toe disease.

(*c*) (Green topped.)

Green Top.—Bulb globular in shape. This variety has a long neck and strong foliage. It matures very slowly and

although only a moderate cropper is very hardy and one of the best keepers. It is very suitable for late spring use.

Effect of Time of Singling on Yield of Swedes per Acre.
(Variety Picton.)

Time of Singling.	Yield per Acre.				Average Yield.	
	1927.		1928.			
	tons	cwts.	tons	cwts.	tons	cwts.
Singled early	20	14	25	5	22	19½
Singled at normal time	22	4	27	12	24	18
Singling delayed	19	7	23	5	21	6

Effect of Width of Singling on Yield of Swedes per Acre.
(Variety Picton.)

Width of Singling.	Yield per Acre.				Average Yield.	
	1927.		1928.			
	tons	cwts.	tons	cwts.	tons	cwts.
Plants 8 ins. apart...	19	7	24	15	22	1
Plants 10 ins. apart	19	18	26	15	23	6½
Plants 12 ins. apart	18	12	25	5	21	18½

Effect of Width of Drill on Yield of Swedes per Acre.
(Variety Picton.)

Width of Drill.	Yield per Acre.	
	1928.	
	tons	cwts.
Drills 24 ins wide	25	16
Drills 27 ins. wide	28	2
Drills 30 ins. wide	23	19

Scottish Fruit Survey, 1926 to 1928.

IN 1926 the Board of Agriculture for Scotland arranged for the three Agricultural Colleges to undertake a general survey of the fruit grown in Scotland for commercial purposes. The survey was undertaken primarily for the following purposes:—

(1) To ascertain the most profitable varieties of the different fruits grown in Scotland with a view to furnishing authoritative advice to growers;

(2) to collect information as to the incidence of diseases and pests.

The survey was completed in the summer of 1928, and the following is an abstract of the salient features of the three reports.

In carrying out the survey it was found possible to bring growers as a whole into closer touch with the activities of the Agricultural Colleges in their respective areas, and the Survey Staff took advantage of the opportunity to give much valuable assistance to growers both in regard to their immediate difficulties and their plans for the future.

Tables are attached showing the extent to which the various kinds of fruit are grown for commercial purposes in the different counties in the areas of the three Colleges.

Raspberries.—Raspberry growing, as regards the acreage under cultivation, is the principal fruit industry in Scotland. The acreage under this crop constitutes almost half of the total area devoted to commercial fruit growing. The crop is concentrated mainly in the counties of Perth, Angus and Fife.

The principal varieties are Mitchell's seedling (Semper Fidelis), which has by far the largest acreage, Antwerp, Hornet, Lloyd George (the acreage of which is increasing rapidly), Fillbasket, the Devon and Beaumforth Seedling. In the south-west and in the Aberdeen College area raspberries are not grown extensively. In Moray and Nairn, however, there are heavy cropping local varieties of robust habit and growth and of considerable merit. These varieties are quite distinct and are of unknown origin. They have been included in the trials of the Aberdeen College for comparison with commercial sorts and have been accepted for trial at the East Malling Research Station.

The varieties Lloyd George and Devon are recommended for all districts with, in addition, Beaumforth (northern area); Beaumforth, Mitchell's Seedling, Bountiful, Hornet (eastern area); and Mitchell's Seedling, Burnett's Holm Seedling, Pynes Royal (on light soils), and Red Cross (western area).

The most prevalent pests are the raspberry moth, raspberry weevil and raspberry beetle, all of which cause considerable damage and loss. A small amount of "Die-Back" has been noted in the Aberdeen College area, and it is suggested that some research work is necessary with a view, if possible, to determine the nature, cause and control of this condition.

Strawberries.—The area devoted to strawberry growing amounts to 2,212 acres. The crop is cultivated mainly in the Clyde Valley but also in the counties of Perth, East Lothian, Angus, Aberdeen, Ayr, Midlothian and Kincardine. The strawberry crop in Lanarkshire represents nearly 37 per cent. of the total acreage of fruit grown in the area of the West of Scotland College, while of the total acreage of fruit in the Aberdeen College area 58 per cent. is under strawberries.

The varieties chiefly grown are Ruskin, Lord Overton, Scarlet Queen, Bedford, Laxton, Garibaldi, King George and Royal Sovereign.

Scarlet Queen, Royal Sovereign (on heavy soils) and Garibaldi should do well in both the northern and eastern areas, while Laxton's Climax, M'Mahon, Aberdeen Favourite, Sir Joseph Paxton and Elton Pine are also recommended as suitable for the northern area, and John Ruskin, Lord Overton and Givon's Late Prolific for the eastern area. In the western area the essential is to obtain plants that are free from disease.

Since 1921 strawberry disease in the Clyde Valley area has caused increasingly serious damage, and must be regarded as a real menace to the cultivation of the strawberry crop throughout the College area. Mildew (*Sphærotheca humuli*), Leaf Spot (*Mycosphærella fragaria*) and Red Plant have also caused damage. The most serious insect pest is the larva of the crane fly (*Tipula oleracea*), commonly called "grub." In the Northern area strawberry plants are remarkably free from disease, and it is suggested that this area would be an excellent source of supply for new stock plants for southern growers.

Apples.—In the West of Scotland apple crops have not been satisfactory, and the area devoted to apple cultivation is being reduced every year. In the Carse of Gowrie district of Perthshire there are nearly 200 acres of apple orchards where, in general, satisfactory results have been obtained, the varieties most frequently grown being (on heavy soils) :—

Early Victoria.	Keswick Codlin.
Grenadier.	Golden Spire.
Worcester Pearmain.	Prince Albert.
Irish Peach.	Washington.
Bramley's Seedling.	Lord Derby.
Bismarck.	Hambling's Seedling.
Tower of Glamis.	Royal Jubilee.

and (on lighter soils) :—

Ecklinville.	The Queen.
Stirling Castle.	James Grieve.
Warner's King.	Charles Ross.
Hawthornden.	Mr. Gladstone.
Lord Suffield.	Lady Sudeley.

While the acreage under apples in the north is small, the climatic conditions obtaining in Morayshire appear to be favourable for an extension of the area under cultivation in that county.

The culinary varieties, Golden Spire, Early Victoria and Bramley's Seedling, do well in all districts, while the following are, in addition, recommended for the respective College areas :—

North.	*East.*	*West.*
Lord Grosvenor.	Grenadier.	Grenadier.
Prince Albert.	Domino.	
Royal Jubilee.	Bismarck.	
	Prince Albert.	
	Lord Derby.	
	Ecklinville Seedling.	For medium to light soils.
	Stirling Castle.	
	Warner's King.	
	Newton Wonder.	

In the case of dessert varieties the most suitable are :—

North.	*East.*	*West.*
Gladstone.	Gladstone.	Allington Pippin.
Irish Peach.	Worcester Pearmain.	Rival.
Worcester Pearmain.	James Grieve.	
Beauty of Bath.	Ellison's Orange.	
	The Premier.	
	Rival.	

Diseases of apples most prevalent are Canker, Coral Spot and Apple Scab, while the most prevalent insect pests are Winter Moth Caterpillars, Woolly Aphis, Apple Sucker and Scale.

Plums.—The zone for plums is much more restricted than that for apples. The areas in which plums are grown to any extent are the Clyde Valley, Midlothian, the Carse district of Perthshire, Brechin district and East Lothian, and the most important variety is Victoria. There would appear to be room for extension in the cultivation of plums (and also pears) in Morayshire.

Victoria is the variety recommended for general cultivation, but The Czar should also give good results, while in the north Early Prolific and Kirke's have been found satisfactory, and Merryweather (Damson).

The plum suffers from insect pests and Winter Moth and Plum Saw Fly have both been troublesome, but the most serious infestation of recent years was that caused by Bud Moth. The Leaf Curling Aphis is always present and constant spraying is essential. Silver Leaf disease claims a few victims each year, but the most virulent diseases are *Eutypella prunastri* and *Diaporthe perniciosa.*

Pears.—In the south-west of Scotland pears do not appear to be a satisfactory crop. There are 29 acres of pears grown in Perthshire, mainly in the Carse district, but here, as in the Clyde Valley, the trees are mostly very old, varying from 50 to probably over 150 years of age.

The following varieties should be the most profitable :—Hessle, Fertility and Conference, but for the eastern area William's Bon Chretien, Dr. Jules Guyot and Durondean are also recommended.

Pear Scab is prevalent and does most damage to the crop, but there is also a considerable amount of Scab Lichen and Moss on the trees.

Black Currants.—This crop is not grown on a large scale but is found in small plantations along with other fruits. However, there has been of recent years a noticeable increase in the acreage of black currants under cultivation in the area of the West of Scotland College. The principal areas of cultivation are the Clyde Valley, Perthshire, Angus, Midlothian, Aberdeenshire, Clackmannanshire, East Lothian, Fife and Morayshire.

The varieties Edina and Baldwin are generally recommended, while Boskoop also may be expected to prove satisfactory in the

north and east. In the latter area Victoria (Goliath) can be grown successfully, and Davidson's Eight in the western area.

Big Bud (Black Currant Mite) and Reversion are common and widespread. The disease *Cronartium rubicola* is present in certain localities. Except in cottage gardens, the position with regard to Big Bud in the northern area has improved during recent years.

Gooseberries.—Of bush fruits gooseberries have been the favourites, but the tendency now is to reduce rather than to extend their cultivation, principally on account of changes in the methods of jam manufacture. The crop is found mainly in the Clyde Valley, Midlothian, Aberdeenshire, East Lothian, and the Carse district of Perthshire.

The following varieties predominate :—Whinham's Industry, Lord Elcho, Warrington, Whitesmith, Golden Lion, Sulphur, Langley Green, Glencarse Muscat and Hedgehog.

Whinham's Industry can be recommended for cultivation in Scotland generally, while other red varieties which grow well are May Duke, Lancashire Lad and Crown Bob in the north and Victoria and Lord Derby in the east.

Keepsake and Careless are the two most suitable varieties generally, while growers in the northern area may also cultivate profitably Laxton's Amber, Bedford Yellow, Leveller, Langley Green, Lancer and Whitesmith, and those in the eastern area Early Sulphur, Langley Beauty and Whitesmith.

The most prevalent pests are Red Spider, Winter Moth, Sawfly, Magpie Moth and Aphis. American Gooseberry Mildew has given considerable trouble in previous years, but it can now be kept under effective control by the adoption of suitable remedial measures. Other diseases encountered are Gooseberry Dieback and European Gooseberry Mildew.

Red Currants.—This fruit is found often in private gardens, but the commercial cultivation of the crop is limited to small plots along with other fruits. The most frequently grown sorts are Comet, Victoria, Raby Castle, Murie Red, Fay's Prolific, St. Madoes Red and Red Dutch.

For the respective areas it is suggested that the following varieties are the best :—

North.	*East.*	*West.*
Ayrshire Queen.	Murie Red.	Victoria.
Comet	Comet.	Raby Castle.
Red Dutch.	Raby Castle.	
Perfection.	Red Dutch.	

Except for aphides, red currants do not suffer severely from insect pests. The only serious diseases are Coral Spot and Leaf Spot.

SCOTTISH FRUIT SURVEY, 1926-1928.

Area of the North of Scotland College of Agriculture.

Acreage and Distribution of Fruit.

County.	No. of Holdings.	Apples.	Pears.	Plums.	Strawberries.	Raspberries.	Black Currants.	Red Currants.	Gooseberries.	Total Acreage.
		acres.	acres.	acres.	acres.	acres	acres.	acres.	acres.	acres.
Aberdeen ...	143	3¾	1/17	⅛	176¾	25½	31	9⅛	19	265⅝
Kincardine ...	37	¾	...	...	48¼	5	4¾	¾	1	60½
Banff	10	4½	...	¼	1½	1⅓	3½	⅛	¾	11¾
Moray ...	28	12¼	1/16	2	8¾	6	11	⅛	1½	36⅔
Nairn ...	4	½	...	1/16	⅓	1¼	½	1/12	⅛	3
Inverness ...	16	4¾	...	...	6⅛	2¼	2	...	1	16⅛
Ross and Cromarty...	21	6½	...	¼	5½	1⅛	5¾	1/16	3¼	22½
Orkney ...	1	...	...	...	⅓	...	...	...	...	⅓
Sutherland and Caithness	Nil.	...	...	...	...	...	...	...	...	...
Totals ...	260	32¾	1/7	2¾	242⅝	42⅓	58½	10½	26⅝	416

SCOTTISH FRUIT SURVEY, 1926-1928.

Area of the Edinburgh and East of Scotland College of Agriculture.

Acreage and Distribution of Fruit.

County.	Apples.	Pears.	Plums.	Raspberries.	Strawberries.	Black Currants.	Red Currants.	Gooseberries.	Total Acreage.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Angus...	2	...	21	747	146	40	½	3½	960
Berwickshire	12	½	⅛	½	1¼	1	...	2	17¾
Clackmannanshire ...	1¼	½	⅛	25½	2¼	25½	...	½	56
East Lothian	23½	4½	11¼	21	155	23	1½	15	254¾
Fifeshire	19½	2	1¼	98	26	21½	3	4½	175¾
Kinross-shire	1	..	...	1	6½	6	...	...	14½
Midlothian	25	4½	22½	38	76½	39	3½	28½	237¼
Peeblesshire	1	...	1	2	13½	1¼	⅛	½	19¾
Perthshire	236	29	18	2,176	169	52	12	14½	2,706½
Roxburghshire ...	16	1½	3	2	9½	2½	...	1½	36
Selkirkshire	1¼	¼	...	1	1	1	...	..	4½
West Lothian ...	8	...	1½	2	22	1½	½	5½	41
Totals ...	346½	42½	80½	3,114	628½	214¼	21½	76	4,523¾

SCOTTISH FRUIT SURVEY, 1926-1928.

Area of the West of Scotland Agricultural College.

Acreage and Distribution of Fruit.

COUNTY.	Apples.	Pears.	Plums.	Raspberries.	Strawberries.	Black Currants.	Red Currants.	Gooseberries.	TOTAL ACREAGE (allowing for intercrop).
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Ayrshire	50½	...	1¾	15¾	90	12	6¾	53	229¾
Dumfriesshire ...	1¼	...	¾	8½	22	4½	½	3½	41
Dumbartonshire ...	2½	...	1½	30½	40	5½	2¼	8¾	91
Kirkcudbright (Stewartry of) ..	½	...	...	...	2	...	...	...	2½
Lanarkshire	155½	61½	249½	86	1,054 [1]	24¼	45¾	372¼	2,048¾
Perthshire (West) ...	¾	...	1¼	85¼	18	1¼	...	½	107
Renfrewshire	¾	...	¼	20	50	9¾	1¾	1	83½
Stirlingshire . ..	54½	8	42	25¼	67 [2]	14¾	9¾	50½	271¾
Wigtownshire ..	...	...	...		3½	2	...	2½	8
TOTALS OF CROPS ...	265¾	69½	297	361¼	1,376	75	66¼	492	2,877

[1] 51 acres grown as intercrop } of the total acreage under bush fruit, viz. 643 acres, 396 are
[2] 9 acres grown as intercrop } grown as intercrop, including 295 acres in Lanarkshire, 45 in Ayrshire and 55 in Stirlingshire.

Thus—Sums of totals of crops will not correspond with totals of areas in each county.

Reviews.

Practical Co-operative Marketing.—A. W. M'Kay and C. H. Lane, Chapman & Hall, 1928; pp. xvii+512; price 15*s*.—Among the many books that have recently been published on the subject of co-operative marketing, on both sides of the Atlantic, this work takes a high place. Mr. M'Kay is Senior Marketing Economist in the U.S. Department of Agriculture, and Dr. Lane is chief of the Agricultural Education Service in the Federal Board for Vocational Education. Their book is based on a thorough knowledge of co-operative marketing of all kinds in the United States, and on an equally thorough understanding of the way in which the ordinary farmer approaches the question of co-operation. Part I deals with the nature and organisation of co-operative marketing associations in general; Part II describes the actual working of the existing associations for the co-operative sale of milk, butter, cheese, poultry and eggs, live stock, wheat, cotton, wool and fruit; Part III discusses the conditions of success, the causes of failure, and the results achieved by these associations. Each chapter closes with a list of questions which the reader may put to himself by way of applying to his own circumstances the experience of others, and with a list of bulletins, &c. for further reference. The book is illustrated with 157 well-chosen plates and

diagrams, and there are a number of appendices, one of which contains a list of the periodical reports relating to crops, markets and agricultural economics issued by the U.S. Department of Agriculture; this list extends to fifteen pages, and gives evidence of the remarkable activity of the Department.

There are about 6,000,000 farmers in the United States, and it is estimated that in 1927 about 2,000,000 of these were members of one or more of the 17,000 marketing and purchasing associations, whose turnover amounted to £500,000,000. The scale of co-operation in the States is thus vastly greater than it can possibly be in Great Britain, but the principles and practice of successful co-operation do not vary with size, and this account of what has been achieved across the Atlantic may be confidently recommended to Scottish farmers and others interested in the matters with which it deals.

Bibby's Book on Milk. Section II. *The Law relating to the Sale of Milk.*—This volume sets out to be a complete and comprehensive handbook on all matters relating to the sale of milk, and is intended to supply full information for the guidance of milk producers and distributors on the problems arising in their daily business.

Beginning with a detailed history of the various acts and regulations affecting the sale of milk, the text brings out the fact that the essence of the law is that milk must be genuine, as it comes from the cow. It proceeds to make out an unanswerable case against the procedure whereby milk below the presumed standard of fat and non-fatty solids is held to be adulterated unless the producer can prove the contrary. Much evidence is adduced to show natural and inevitable variation in the composition of milk, and many authorities are cited in favour of an alteration in existing procedure.

Reprints of Acts of Parliament with notes interpreting these, a large selection of decided law cases, a collection of evidence regarding the composition of milk, prints of Statutory Rules and Orders, official correspondence concerning the Acts, and a section comprising the Milk Laws of Scotland, with Rules, Orders, Byelaws and Circulars, make up a most useful compendium of information on the subject.

Mr. John Hanley, Messrs. Bibby's Laboratory manager, is responsible for the compilation of the material and the text.

Sugar Beet in France, Belgium, Holland and Germany. A. Bridges and R. N. Dixey, Clarendon Press, Oxford.—Messrs. Bridges and Dixey must have made excellent use of their time in the three short visits they paid to these beet-growing countries in the years 1926 and 1927, for their report is a model of careful observation and recording of facts, clear arrangement and presentation of these, and sound judgment of their bearing on home practice. The authors stress the importance of the labour factor, and bring out the fact that in these Continental countries the

best returns are obtained by small peasant proprietors who find their labour almost entirely within their own households. Other important factors are the use made of leaves, tops and pulp as fodder for cattle, and the comparatively high yields—both per acre of roots and of sugar content—on the extensive area of suitable soil in these countries. There are besides matters connected with the placing and running of factories, costs of transport, and arrangements for marketing which appear to favour the Continental producer. The authors therefore draw the general conclusion that " no Continental practice in relation to the growing of this crop should be adopted or even recommended in this country except after careful trial under British conditions of soil, climate, and above all labour."

Full and well-authenticated information is given concerning cultivations, manuring, seed and sowing, harvesting, yields, by-products, costs and returns, and the effect of beet cultivation upon general agriculture; and an appendix gives examples of contracts between growers and factories.

Feeding Stuffs. Arthur S. Carlos, B.Sc., F.I.C., Chapman & Hall.—This is quite a useful and unambitious elementary textbook on the main foodstuffs offered on the market. After a general chapter on chemical composition and functions of food the various substances are dealt with *seriatim*, the origin, method of production and manufacture, and their use being in each case indicated.

The making up of compound foods is then dealt with. This leads on to the comparative value of foods and the methods of estimating these, and to a short description of scientific rationing of animals. A summary of the relevant sections of the Fertilisers and Feeding Stuffs Acts with schedules, regulations, &c. will be a helpful guide to interested parties, and tables of statistics of the World's trade in feeding stuffs bring together much useful information from many sources.

Agricultural Entomology. D. H. Robinson, B.Sc., and S. G. Jary, B.A. Duckworth.—Insect pests on stock and crops have been attracting increased attention in recent years as the losses due to their activities have been more realised both at home and throughout the Empire; and there is an urgent call for trained entomologists to carry out investigation and to suggest measures of control. No agricultural student could have a more satisfactory introduction to the subject than this short and well-arranged textbook. After a brief and concise account of the elements of Entomology, the authors pass on to deal with the insects which are important pests, and in those cases where methods of control are already known they describe these succinctly. Sensible advice is given regarding control of insect damage generally, and the usefulness of cultural operations and variations of rotation is emphasised. Certain animals such as eelworm, whose attacks and their effects are similar to those of insects, are dealt with

in appendices. Useful hints are given on collection, preservation, and examination of specimens, and a short bibliography supplies references to authorities on special branches of the subject.

Messrs T. Whitehead, M.Sc., Ph.D., and J. F. Currie, N.D.A., University College of North Wales, Bangor, have contributed the following preliminary note on the development of secondary symptoms of potato leaf-roll in the year of infection.

Potato Leaf-Roll.

When well-grown potato plants are infected in the field with leaf-roll, they either show no symptoms at all or, at most, a curling and coloration of the upper leaves which are regarded as "primary" symptoms; their progeny, however, develop the full or secondary characters of leaf-roll about one month after appearing above ground. On the other hand, it has been shown by Murphy (1) that when sprouting tubers are infected, the plants they give rise to assume the secondary symptoms of the disease. It seems possible to the writers, therefore, that a stage occurs in the growth of a potato plant up to which these secondary characters might develop during the year of infection, and beyond which it would be necessary to grow on the progeny before infection could be demonstrated. In order to test this possibility, plants have been raised from tubers planted at weekly intervals so that there was a difference in age of nine weeks between the oldest and youngest series. All were infested for the same length of time with an approximately equal number of infected greenfly, the experiment being carried out under controlled conditions in a glasshouse. Under these circumstances plants of the variety Arran Comrade, from the youngest up to those planted eight weeks before infestation with the greenfly, developed pronounced symptoms of secondary leaf-roll; those planted one and two weeks earlier showed definite rolling of the upper leaves only, whilst still older ones either remained normal or exhibited doubtful rolling in the upper leaves. In another variety (Kerr's Pink) secondary symptoms developed in plants arising from tubers planted up to six weeks before infestation, doubtful primary characters showing in those planted seven, eight and nine weeks before infestation, whilst older plants developed no symptoms.

Full details will be published elsewhere, but it is felt that attention should be drawn to these facts, without delay, in view of their importance to the Scottish seed potato industry. Although it is probable that the infestation of the plants in this experiment was heavier than occurs normally in the field, the results indicate that when late planting is followed by an early infestation with greenfly, there may be an apparently inexplicable increase in the amount of leaf-roll found in the crop. This may conceivably afford an explanation of the fact that leaf-roll, although not nearly so serious as in England, does occur to a great extent in some stocks in Scotland (2). From the growers'

point of view it is of importance to know that, under the conditions mentioned above, it is possible for potatoes to become infected at a sufficiently early stage in their growth as to develop secondary symptoms of leaf-roll in the same season. Where this seems likely to occur there is special need for early and constant rogueing out of diseased plants. Apart from the presence of leaf-roll affecting the value of the crop for seed purposes, the early spread of disease will result in such an increase in the number of plants showing secondary leaf-roll that the yield may be seriously reduced. It seems clear, also, that the amount of leaf-roll found in a crop does not necessarily afford a measure of its prevalence in the seed from which it was grown, unless the plants had passed the critical period before the onset of greenfly.

REFERENCES TO LITERATURE.

(1) Murphy, P. A.—On the Cause of Rolling in Potato Foliage; and on some further Insect Carriers of the Leaf-Roll Disease. *Sc. Proc. R. Dublin Soc.*, vol. 17, No. 20, 1923.

(2) Anon.—Leaf-Roll, Mosaic, and Related Diseases of the Potato. Part I. *Sc. Journ. of Agric.*, vol. 8, No. 1, Jan. 1925.

Machinery on Farms in Scotland in 1925.

THE Report on the Census of Agricultural Production in Scotland taken in 1925, which has formed the subject of a series of three articles in this JOURNAL, contains particulars of the motive power used on farms and of the machines driven by the engines. The following table gives a comparison of the figures obtained in 1925 with those obtained in 1908 and 1913.

Type.	1908.	1913.	1925.
(A) *Fixed or portable*—			
Steam	2,036	1,368	401
Gas	80	103	89
Oil or Petrol	1,858	3,766	11,137
Electric	25	52	187
Wind	} ...	5,106	{ 513
Water			2,829
Not stated	56	...	...
(B) *Motor Tractors*—			
For field operations	...	...	1,400
For stationary work	...	...	291

The total of the comparable items has been almost trebled since 1908. Steam engines have been reduced to one-fifth of their earlier number, while petrol and oil engines have been multiplied six-fold. The former in 1908 constituted one-half of the total of the comparable items, while the latter in 1925 accounted for no less than 94 per cent. of these items. Gas and electric engines are comparatively few, but the latter have

made a large proportionate increase. Motor tractors are a new feature of farm equipment. The number returned in 1925 is 1,691, comprising 1,400 for field operations and 291 for stationary work.

The returns are analysed in Tables 26 and 27 in the Appendix to the Report. The former gives for each division (*a*) the actual number and horse-power of each type of engine, and (*b*) the number and horse-power per 10,000 acres of land under crops and grass.

Wind-mills are most numerous in the northern and north-western division, and water-mills in the north-eastern, while steam engines are most used on the large farms of the south-eastern division. Oil and petrol engines are most largely used in the north-eastern division, where there is one to every 300 acres of farm land, but their average horse-power is less than that of the engines in use in the east central and the south-eastern divisions. Engines of this type provide 102,200 horse-power, while all other types combined provide 29,600.

Of the 1,691 motor tractors in use, the three eastern divisions have each over 400, the western and south-western over 300, and the northern and north-western 120. The south-eastern division has the largest proportion for its area—one to about 2,000 acres of farm land.

Appendix Table 27 gives similar details for each of the holdings groups. Farms over 100 acres have 81 per cent. of the steam engines returned, 77 per cent. of the electric engines, and from 57 to 65 per cent. of the other types. Holdings not exceeding 15 acres have a negligible number of engines. The proportions between the number of engines and the number of holdings in the other classes are as follows :—

Holdings Group.	1 Engine to	Holdings Group.	1 Engine to
15 to 30 acres	12 holdings.	100 to 150 acres	2¼ holdings.
30 ,, 50 ,,	6 ,,	150 ,, 300 ,,	1½ holding.
50 ,, 100 ,,	3 ,,	Above 300 ,,	1 ,,

Of the 1,400 tractors used for field operations, 92 per cent. are on holdings exceeding 100 acres, and of those used for stationary work 87 per cent. Of the holdings over 300 acres, between one-fourth and one-fifth have tractors, and of those between 150 and 300 acres about one-twelfth.

Appendix Table 28 shows the number of power machines returned in each county, divided into three classes—threshing-machines, bruisers, &c., and hay and straw cutters. In Scotland as a whole the number of threshing-machines is equal to the number of holdings exceeding 150 acres, with the addition of half of those between 100 and 150 acres; the number of bruisers to the number of holdings exceeding 300 acres, with the addition of three-fifths of those between 150 and 300 acres; and the number of hay and straw cutters is somewhat less than the

number of holdings exceeding 300 acres. The distribution among the various counties varies considerably, according to the prevailing system of agriculture. Thus Aberdeen has a threshing-machine for every holding exceeding 75 acres, or more than double the average number, i.e. the number it would have according to the distribution in Scotland as a whole; Ayr on the other hand has one for every holding exceeding 300 acres, with the addition of one-third of those between 150 and 300 acres, or a little over one-fourth of the average number. Aberdeen has also nearly double the average number of bruisers, while Berwick has only one-fourth of the average. Ayr has double the average number of hay and straw cutters, while Angus has only one-third of the average number.

Agricultural Conditions.

THE weather during December was generally mild and open and suitable for seasonal work; satisfactory progress was made with ploughing, but the carting of manure was rendered rather difficult owing to the wet condition of the land. Throughout January the rainfall was light, but there were occasional falls of snow in most parts of the country, while severe frosts occurred frequently in practically all areas. Every opportunity was taken to press forward with ploughing and other seasonal work, but the soil was generally frostbound and at the end of the month ploughing was in arrear in many areas. Good progress was, however, made with the carting of manure, while the threshing of grain was well advanced in several districts. In Orkney, Shetland, Caithness, Harris and Uist, and to a certain extent in the Lothians the weather conditions during the first three weeks of January were rather more favourable for cultivation and in these districts farm work made good progress. During the first week of February the weather was mild and open in most districts and some progress was made with outdoor work. Frost of unusual severity was, however, general during the remainder of the month and there were heavy falls of snow in many areas, the roads being blocked in some districts. Throughout this period cultivation was practically at a standstill, the only outdoor work possible being the carting and spreading of manure. Ploughing was more or less seriously in arrear in most districts at the beginning of March.

The winter sowing of wheat was well advanced at the beginning of December in Moray, Angus, South-west Fife, the Lothians, Berwick, Stirling and parts of Perth and Lanark, but elsewhere the work made slow progress. Speaking generally the weather during the last three months has been unfavourable for the crop and the plants are now rather backward; in many districts the severe weather during February checked growth and in most areas the crop became browned by frost. No spring sowing had been accomplished at the end of February.

The reports on potato stocks furnished at the end of January indicated that only a small proportion of last year's crop had then been taken from the pits, but that in practically all cases where the pits had been opened the tubers were in good condition; very little disease or damage by frost had at that time been observed and, speaking generally, the potatoes were of good quality.

The wintry weather during January would doubtless have had a detrimental effect upon some sheep stocks had not the flocks been generally in good condition when the cold weather began. Ewes throve well and benefited by the dry weather and the absence of storms. Lambing began among early flocks in Angus and Berwick, with satisfactory results. At the beginning of March it was reported that ewes, while still generally in fair condition, had suffered more or less severely from the inclement weather during February and that hand-feeding had been necessary on many farms. In Clackmannan, Kinross, South-west Fife, Shetland, Ross, Kintyre and Bute, Renfrew and Dumfries the flocks were reported to be doing well, but in Wigtown, North Ayr and Perth they were said to have gone back in condition. Lambing prospects were on the whole considered fairly good. In the districts where lambing had begun before the end of February, the fall of lambs was satisfactory, but in Wigtown the death-rate was above the normal. In South-west Angus the lambs have required hand-feeding and more than the usual amount of care, while in South-east Perth difficulty has been experienced in obtaining sufficient fresh turnips to assist the ewes in maintaining the milk flow.

The reports on turnips and swedes at the end of February showed considerable variation; in a number of districts supplies were plentiful and in good condition, while in other areas the tubers were frosted in the pits and more or less seriously damaged. Supplies of turnips were reported to be falling low in Ross, Central and North-east Perth, Clackmannan, Kinross, Fife, Islay and Jura. Sugar-beet pulp has not been much used as a substitute for turnips, partly on account of its higher price this year; in North-east Fife, however, a considerable quantity has been fed, with satisfactory results. At the end of February fodder was reported to be running short in Kincardine, North-east Angus, South-east Perth, North-east Fife, Dumfries and Kirkcudbright.

The supply of regular labour has been adequate for the requirements of the season in all districts.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Bateson's Experiments on Bolting in Sugar Beet and Swedes. *By Sir A. D. Hall, K.C.B., Director of the John Innes Horticultural Institution. Journal of Genetics, Volume* 20, *No.* 2, *Nov.* 1928.—The ordinary stocks of the cultivated varieties of *Beta maritima*—mangolds, sugar beet and garden beet—constitute mixed populations mainly biennial in habit but containing a certain small proportion of individuals which will "bolt" under ordinary conditions of sowing in the open. This proportion rises rapidly under conditions favourable to bolting, e.g. early sowing, a check to growth. Sowing under glass at the beginning of the year and transplantation into the open about April will induce upwards of 70 per cent. of the seedlings to bolt. Selection of seed for two or three generations from plants which do not bolt under such forcing conditions gives rise to strains of seed from which the bolting tendency has been so far eliminated that none will bolt under ordinary conditions of sowing in the open or even when "forced." Though "bolting" is markedly affected by environment, by conditions of nutrition, temperature, &c., to which the plant is subjected, the individuals differ in their proneness to bolt, or in the resistance they offer to conditions that encourage bolting. These differences are shown to be genetic in origin and are inherited. Thus while the ordinary mixed stocks contain individuals which will bolt without any special stimulus and others which will not bolt even under the most forcing conditions practicable, it is possible to extract a race consisting only of the latter, which might be termed a pure biennial race. The evidence suggests that high resistance to bolting as compared with low resistance is not a simple character, but it is insufficient for the framing of a definite factorial scheme.

Leeks behave like beet, though the tendency to bolt is revealed only when specially early sowings are made in December or early January. Onions follow a different rhythm; bolting is not induced by early sowing.

From the practical point of view the experiments demonstrate that commercial stocks of seeds of mangolds, sugar beet or garden beet can easily be freed from strains with any susceptibility to bolting under normal conditions of growth.

The Nitrogen Content of different Varieties and Strains of Mangel. *By E. Lindhard. Tidskrift for Planteavl.* 34 *Binds*, 3 *Haefte*, 1928.—1. In a breeding experiment with mangel at Lyngby single roots were selected and the offspring of each root analysed for the content of nitrogen and dry matter. The lines with a low content of dry matter had a high content of nitrogen in dry matter, the relation being a decrease in content of nitrogen of 0·1 per cent. for an increase of 1·0 per cent. of dry matter.

2. The same relation was found in different varieties and strains of mangel, viz. :—

	Per cent.	
	Dry matter.	*Nitrogen in dry matter.*
Sugar Beet	24·4	0·76
Mangel, Sludstrup strain	12·1	1·09
Taaroje strain	10·8	1·19

Other varieties showed the same relation, except a strain of Half Sugar Beet with high percentage of dry matter and a low percentage of leaves, which had a relatively high content of nitrogen, and a mangel Barres (Stryno strain), with low content of dry matter and a high percentage of leaves, which had a low content of nitrogen.

3. In experiments with fertilisers the content of nitrogen increased regularly on dressing with increasing quantities of nitrogenous manure, the increase on average of 11 experiments amounting to 0·4 per cent. (from 1·0 to 1·4) on dressing with 750 kg. nitrate of soda (Chilesalpeter) per ha.

4. Of the total of nitrogen usually 60 per cent. is bound in proteins and 40 per cent. is amides, nitrates and ammonia, but in large roots (heavily manured) the amount of nitrogen bound in proteins can be less than 30 per cent. and that bound in amides more than 40 per cent.

"Finger and Toe" Experiments in Mid-Wales involving the Use of Resistant Varieties of Swedes. *By D. Walter Davies, B.Sc., University College, Aberystwyth, and Moses Griffith, M.Sc., and Gwilym Evans, B.Sc., County Agricultural Offices, Dolgelly. (Welsh Journal of Agriculture, Volume 4.).*—The superior resistance of the Danish strains to "finger and toe" is amply proved by these trials. None of them is altogether immune, but the degree of infection of some of the strains is very slight when compared with British varieties included in these trials. There is no doubt that the Danish varieties are capable of giving a substantially higher yield per acre on heavily infected land. They are considerably outyielded by some of the British varieties at any rate on healthy land, but possess better keeping qualities. This is the experience of many farmers who have already grown them in this area during the past few seasons. Bearing this in mind it would be often advantageous to sow part of the swede crop with varieties of good keeping qualities even on healthy land, where roots are required to last until the end of the winter months. An additional point in their favour is their comparative resistance to mildew, which has caused considerable damage to the swede crop in this area in the past. On the other hand, Wilhelmsburger seems to be the most susceptible strain to the attacks of the Swede Midge Fly.

It is important for farmers to realise that there are several strains of Danish Bangholm swedes, but only a few strains are reputed to be resistant to "finger and toe," among them being the Hernig and Studsgaard strains, and also the Otofte strains of the variety Wilhelmsburger. Again, not only is the strain important, but there is evidence to suggest that the source of seed is equally significant. Finally on farms where "finger and toe" is troublesome and lime difficult to obtain, farmers would be well advised to consider the introduction of some of these resistant strains of swedes. At the same time liming would be an additional insurance against the ravages of the disease.

SOILS.

Crop Response to Lime on Acid Soils. *R. E. Stephenson. Oregon Agric. Expt. Station. Soil Sci., XXVI,* 6, 423 (1928).—The conclusion reached is that in diagnosing the condition of poor, acid or infertile soils by laboratory methods great care is necessary. It may be better to build up and maintain general fertility rather than to use heavy applications of lime, for a soil with a good supply of the essential nutrients may be quite fertile although acid. Soil acidity is often found to be accompanied by poverty in phosphates and nitrogen.

A Preliminary Note on the Effect of Sodium Silicate in increasing the Yield of Barley. *R. A. Fisher, Rothamsted Experimental Stn., Harpenden. Journ. Agric. Sci., XIX,* 132 (1929).—It was found that the addition of sodium silicate increased the yield of barley to a considerable extent, the effect being most marked when no superphosphate was added. The amount of phosphate removed annually in the crop was greatly increased in the plots which received silicate, and the conclusion is reached that the addition of silicate increases the amount of soil phosphates available to the plant.

Studies in the Geology and Mineralogy of Soils. *Robert Hart, Edinburgh and East of Scotland College of Agriculture. Journ. Agric. Sc., XIX,* 90 (1929).—A detailed account is given of the geology and mineralogy of Boghall Experimental Farm, Midlothian. This small area contains a variety of different rocks, and most of these rock groups are covered with glacial drift. In spite of the differences in the rocks there is similarity in the mineral content of all the soils derived from the glacial drift, and the minerals are chiefly those found in the local rocks.

The soils on the drift material contain potash, phosphate and lime-bearing minerals.

Texturally there are considerable differences, the soils on the boulder clay being heaviest and those on the fluvio glacial material very variable.

Action of Frost on Soil. *Jacob, A., Die Ernährung der Pflanze, Berlin,* 1928. *Vol. 24, No. 3, pp.* 40-43, 3 *tab.*—It is known that frost is one of the principal agents in the disintegration of rock, and in its transformation and final conversion into soil. This action continues to be exercised on the soil increasing the proportion of fine particles, but with extreme slowness. On the other hand frost has an immediate effect on soil colloids: e.g. it breaks up compact clayey soils into separate lumps. According to Ehrenberg this effect is not due solely to the expansion of the interstitial water, but also to the growth of ice crystals. The resulting lumpy texture increases the permeability and

aeration of the soil, which tends to dry it and facilitate its cultivation without risk of its again uniting into a solid mass. The solidification is apt to be renewed, however, as a result of heavy spring rains, also in many vegetable soils. Attempts have often been made to attribute the beneficial effect of frost to the fact that it renders soluble the nutritive elements in the soil, but this could not be conclusively proved experimentally, even by Neubauer's method. On the other hand, Bätz has shown that the total surface of the particles of a granite soil has increased by 6·13 per cent. after exposure to frost. This effect by flavouring a lumpy texture of the soil is directly beneficial to plant growth, which shows that the old saying "If the ground does not freeze the crop will be thin" has not lost its meaning in countries with a cold winter.

ANIMAL BREEDING.

Cattle.

Inherited Epithelial Defects in Cattle. *F. B. Hadley and L. J. Cole*, 1928. *Research Bulletin No. 86, Agric. Exper. Stat. Univ. Wisc., Mad.*—In this bulletin is described the inheritance of a characteristic which is lethal to new born calves in the Friesian breed of cattle. The condition is of a pathological nature, and may be described as new born calves which were born at full time exhibiting characteristic skin and mucous membrane lesions such as defective formation of the skin below the knees, one or more undeveloped claws, deformed ears, defects in the covering of the muzzle, and in the mucous membrane of the nostrils, tongue, hard palate and cheeks. This defect does not appear to be associated with faulty nutrition or with thyroid or other internal gland disturbance of the mother.

In all, 55 defective calves were studied occurring in 18 different herds, all, with one exception, located in the State of Wisconsin, U.S.A. All these calves traced to common foundation stock, involving the famous bull Sarcastic Lad and cows of the Johanna family.

The results show that this defect is inherited in a simple recessive manner. The direct financial loss in certain herds was considerable, especially as it gave those herds in which it occurred a bad name, so that sales of stock from them were made difficult. The writers state that the best economic procedure is to dispose at once of any bull which throws a defective calf, and if circumstances make it necessary that a bull be selected from the same herd or a closely related line, that the breeding records should be studied carefully in order to prevent any inbreeding to an animal which may carry this recessive condition.

Complete domination of this defect would take a very long time, and it might never have become so concentrated as it has but for this famous bull which carried the recessive defect. The bull himself in his appearance could be in no way judged to carry it; it could only be attributed to him as the results of his progeny.

It is interesting to note that a similar condition has been observed in Holland, presumably in animals of the same original stock, and it is reasonable to think that the defect was imported into America.

Breeders in Britain will be glad to know that no reports of this condition in the British Friesian have come to hand, but it is always well to be on the lookout and to know what to do and do quickly, namely, discard from the breeding herd the bull and if possible the cow which produced the calf.

Relation between Length of Gestation Period, Birth-Weight, and Sex of Dairy Calves: Experiments with Dairy Cattle at the Washington Station. *E. V. Ellington and J. C. Knott.* 1927. *Washington Col. Sta. Bull.* 222, *pp.* 18-21.—Records of the station herd showed that the gestation period for three breeds of dairy cattle on 53 female calves averaged 277·9 days and on 52 male calves 281·7 days. In all cases the male calves had an average higher birth weight than the female calves.

Similar data obtained from the herd at the Washington State Penitentiary showed that 54 male calves were carried an average of 280·4 days and 48 female calves 278·7 days. Of the male calves 32 were carried more and 22 less than 280 days, and of the female calves 22 were carried more and 26 less than 280 days.

Comparison of Purebred and Grade Dairy Cows. 1928. *J. C. M'Dowell, U.S. Dept. Agr. Circ.* 26, *p.* 7.—A comparison of the records of 29,397 purebred and 71,745 grade cows of four breeds showed that the purebred cows consumed 23 per cent. more feed and produced 10·6 per cent. more milk and 6·7 per cent. more butter fat per cow per year than the grades. The yearly income per cow was 9·7 per cent. greater for the purebred cows. Up to 13 years of age the

purebreds excelled the grades in milk production, and to 11 years in butter fat production and return over feed cost. After these ages the grades slightly excelled the purebreds.

The author suggests that the reason the purebreds did not excel the grades more than the figures show was in part due to closer culling of the grades, but mainly to the constant use of selected purebred sires in the production of the grades.

Development and Present State of Cattle Herd-Books. *Engeler, W. (Aus dem Institut für Tierzucht und züchtungsbiologie der Technischen Hochschule München).*—The first part of the work is occupied with the historical development of herd-books from a theoretical point of view. Making use of the extensive agricultural literature of classical times, the Middle Ages, and specially of German-speaking countries and of economic records, the author has studied the use of technical annotation in breeding registers. He shows that up to the end of the 18th century it was not employed for cattle breeding, though it was much used in the breeding of horses and sheep.

In the first half of the 19th century breeding came under the influence of the theory of the persistence of characters which had results of fundamental imporance on the outlook upon and the keeping of herd-books, which were then established also for cattle breeding. This is shown by quotations from zoological literature and by examples drawn from breeding practice.

As a reaction against the theory of persistence and against the consequent one-sided evaluation of the influence of heredity, at the beginning of the second half of the 19th century the doctrine of individual potency was formulated. Its main practical consequences were the recognition of the necessity of taking into consideration the individual characteristics of an animal and of describing them in technical terms in the breeding registers. The results of the genetical science of the day, the establishment of methods of criticism and their systematic application, gave to the keeping of cattle herd-books a scope which cannot be much widened to-day. The results of the modern theory of heredity, which at first merely confined the importance of noting individual characteristics in the herd-books, are now particularly valuable as providing genetical explanations of all the information gathered in the notes.

After this historical survey of the theory of the subject there is a short account of practical methods and the technique of keeping herd-books of cattle-breeding in Europe and other continents. Earlier practices are dealt with, then, more particularly, those in use to-day by official or private associations of breeders with regard to the conditions of entry, issuing of certificates of pedigree (control of service, birth and branding) and the subject matter and form of the herd-book. The countries considered are: Great Britain, France, Germany, Switzerland, Austria, Holland, Denmark, Sweden Norway, Belgium and the United States. The facts are taken from the administrative measures of these countries, statistical enquiries, and from the elaboration of private and printed herd-books, and are made clear by means of numerous formularies and tables.

Part II contains a summary of the whole and a critical examination of the facts. It shows that practical questions concerning the methods of keeping herd-books can no longer be generalised because they are too dependent on special systems for the encouragement of breeding in each country and each breeding district. The conditions for entry form an essential criterion for the conception of the aim and work of manuscript registration.

These investigations have brought into prominence one fact of general importance, which is that in the present practice of keeping herd-books there is still a lack of uniformity of method which almost prevents comparisons. On the other hand, even to-day, many of the observations made by breeders cannot be included, and still less expressed, in figures. These results confirm the necessity of endeavouring to obtain an agreement and uniform systematisation of the keeping of herd-books in different countries, and on some aspects an international outlook.

Pigs.

Swine Feeding and Breeding Experiments at the Iowa Station. 1927. *Iowa Sta. Rpt., pp.* 17, 18, 21.—Different breeding systems with swine. Purebred Poland China sows were "double mated" with purebred Poland China and Duroc Jersey boars. The resulting pigs were either purebred or crossbred. They were carried through the suckling period as mixed litters and fed out separately after weaning. The crossbred pigs weighed more at weaning time, reached market weight sooner, and required less feed per 100 lbs. of gain than the purebred pigs.

Pig Breeding in the Open Air. *Naumann, Zeitschrift für Schweinezucht, Neudamm,* 1928, *Nr.* 17, *pp.* 270-271.—The author attributes the numerous ailments of pigs bred under highly specialised breeding systems to unhygienic conditions. In the pig breeding which is under his direction in East Prussia there is a "Back to Nature" system in practice. Except during the two weeks preceding birth the sows are not allowed in the sties; the boars remain there no longer. The animals remain in the open air even during the most severe cold, their only shelter being a hut made of piled bundles of compressed straw with two openings in the sides. The author has obtained excellent results from this method of breeding and the stock is composed of strong healthy animals. He protests also against the use of the nasal ring, which not only worries the animal but also damages its health. Pigs should be given the chance of rooting in the earth with their snouts, and plantations of Jerusalem artichokes should be grown adjoining their pasturage, where they can obtain part of their food even in winter.

Poultry.

The Effect of Inbreeding and Crossbreeding on Fowls. *L. C. Dunn.* 1927. *Zeit. f. Induk Abs. u. Verer.*—Since 1920 inbreeding experiments in fowls have been in progress at Storrs. In spite of seven years' work no family has been prolonged beyond five generations of brother by sister matings, and the writer has had to resort to backcrossing half-brother sister, and occasionally to aunt by nephew or double cousin matings in order to keep some of the families alive, while of four families begun since 1920 two have survived. Although inbreeding, because of its effect on embryo mortality, is the most important cause of the extinction of these families, the deaths have not all been due to this cause. Several epidemic diseases have made the experiment very difficult to carry on and have hastened the deaths of some of the inbred families. Likewise the decline of the inbred lines in egg-production has been accompanied by rather poor egg production on the part of the non-inbred stock, indicating that conditions were not suitable for measuring the effect of inbreeding in this character. It must be said, however, that in any single year when conditions for both inbred and outbred fowls are about the same, the average number of eggs laid by the outbred birds is always greater than the average of the inbred birds.

The most interesting new information has been obtained from the results of crossing the inbred lines. Two of the original families and one of the new families begun in 1922 were crossed in 1925. The comparison of the inbred with the outbred progeny from the same families showed that the cross had an immediate effect on the viability of the outbred embryos and on the growth, survival, and maturity rates of the outbred chickens. The outbred chickens were superior in most respects and at all ages to their inbred half brothers and sisters from the same mothers.

Data are given on the hatchability of eggs. In general, it is seen that the percentage of eggs hatched has tended to decrease as inbreeding has proceeded, although in different degrees in different families. In addition to the decline in the percentage of eggs hatched, the decline in the number of families surviving is of considerable importance. For such a character as hatchability it is obvious that there exists a lower limit beyond which the percentage of embryos surviving cannot decline, for this leads to the death of the family. This limit under our conditions is probably in the neighbourhood of 25 or 30 per cent. hatchability, and several families have fallen below this minimum and have died out in the early generations. An apparent rise in the percentage of embryos which hatched in the fourth and fifth generations is due to the survival of a single family in which a fairly high rate was maintained. The results show an average decline in hatchability and a selective elimination of the poorest families in this respect.

The same inbred hens were crossed first with their own brothers to produce inbred progeny and later to a male from another inbred family. Both male and female parents when inbred were shown to give a low or mediocre hatchability. The substitution of another equally inbred male for the own brother was shown to increase considerably the hatchability of the eggs, in the two cases cited from 47 to 85 per cent. and from 56 to 73 per cent. The maternal inheritance in the two cases is the same, since the same fowls produced both the inbred and outbred eggs.

The Recognition of Sex in Hens' Eggs. *Enriques Paolo, Archivio di scienze biologiche, Naples,* 1928.—In some countries there is a widely spread opinion that elongated eggs give rise to pullets and round eggs to cockerels. According to Lienhardt the eggs of a pure breed of fowls can be divided into

two groups by weight, the heavier group producing cockerels and the lighter pullets.

The author undertook some experiments to test whether there is any foundation for these opinions, and came to the conclusion from his results that a classification of eggs into two groups based on weight or shape has no bearing on the sex of the chickens.

He has, however, been able to recognise a very slight difference between the average weight of eggs giving rise to cockerels and those giving rise to pullets; the latter weighed about 6·6 gm. more than the former. But he found no connection between the shape of eggs and the sex of chickens.

ANIMAL NUTRITION.

Cottonseed Meal as a Feed for Dairy Calves. *Reed, Huffman and Addington. J. Dairy Science, XI, No. 6, 1928, p. 488.*—Owing to the general opinion that cottonseed meal contains a poisonous principle, this feeding stuff is seldom recommended as a feed for calves. The present paper gives a preliminary report on the effect of feeding cottonseed meal on the health of growing dairy heifers.

Cottonseed meal injury in cattle is similar, if not identical, to the injury produced when too much concentrates in proportion to roughage is fed.

At least two pounds of cottonseed meal daily can be fed to calves five months of age or older which receive all the silage and hay of good quality they will eat.

There was no appreciable difference in the sleekness of coat and pliability of hide between the heifers receiving cottonseed meal and linseed meal.

There was no appreciable difference between the rate of food passage through the digestive tract by the heifers receiving cottonseed meal and linseed oil meal.

There was no measurable difference in the consistency of fæces excreted by the two groups of heifers.

A Study of the Factors affecting the Growth of Dairy Heifers. *Bender and Bartlett. J. Dairy Science, XII, No. 1, 1929, p. 37.*—Experiments were carried out to determine the best possible ration to feed dry which would produce 100 per cent. normality in calves when 180 days old, to find the earliest age at which calves could be weaned from a milk diet, and to reduce the cost of raising calves to six months of age.

As a result of these experiments it was found that calves can be successfully raised on a dry grain mixture after being weaned from milk when thirty days old. On a sound dry grain mixture and alfalfa hay fed *ad libitum* these calves will be 100 per cent. normal for weight and height when compared with Eckles normal figures. A dry grain ration will cut the feed costs on raising calves to six months of age from 25 to 50 dollars, depending on the feeding methods used. This method of feeding saves labour costs and does not harm the breeding or productive ability of the individuals.

Increased Milk Production from Use of Ensilage. *Von Csiki; Deutsche Landwirtschaftliche Tierzucht, Hanover,* 1928, *Jg.* 32, *Nr.* 15, *pp.* 300-302. *International Review of Agric., Nov.* 1928.—The writer fed 14 dairy cows for 30 days on ensilated fodder and compared their yield during this time with that of the 15 preceding and 15 following days during which the cows received ordinary food. He found an average daily increase during the period of ensilage-feeding of 6·88 to 7·56 litres per head, but in this experiment he did not investigate its influence on the fat content of the milk. Another experiment was made on three cows which were separately fed and kept under observation. These three animals received, in addition to a known feed of oil-cake, bran, beetroots and husks, during the first 10 days of the experiment a known quantity of dried maize stalks; during the next 11 days ensilated maize straw; then for 9 days ensilated meadow hay of medium quality; and during the last 9 days ordinary hay. The writer shows in tables a comparison of the protein and starch content of the different foods given, also their effect on the yield and fat content of the milk; it is seen that the yield and fat content of the milk are noticeably increased by feeding with ensilated fodder, and that each is again lowered by a return to feeding without ensilage.

The writer intends to continue his investigations and next year to publish his results on ensilage-feeding returns.

The Comparative Nutritive Value of the Proteins of Linseed Meal and Cottonseed Meal for different Animals. *Bethke, Bohstedt, Sassaman and others. J. Agric. Res.,* 36, 1928, *p.* 855.—As a result of experiments with various types of animals the authors have drawn the following conclusions.

The proteins of linseed meal and cottonseed meal were equally well digested, possessed the same biological value, and were equally efficient in supplementing the proteins of corn, when fed on the same protein basis to young rats.

Rats and pigs did not respond alike when fed identical rations containing linseed meal and cottonseed meal. The latter proved toxic to pigs.

The feeding of linseed meal and cottonseed meal to growing chicks, either as the chief source of protein or in combination with an animal protein (meat scraps), showed that the proteins of cottonseed meal were much more efficient than those of linseed meal. No toxic effects were observed with this species.

Evidence is presented which indicates that the age or maturity of the chicken may influence its response to linseed meal or cottonseed meal feeding.

Cottonseed meal and linseed meal were of nearly equal value when fed to beef calves in combination with alfalfa hay, corn silage and corn.

It is pointed out that not all species of animals respond alike to linseed meal or cottonseed meal feeding, and that the conflicting results obtained with these two feeding stuffs may, wholly or in part, be accounted for on the basis of toxicity or species variation.

Studies in Mineral Metabolism—III. Breeding of Cattle on Phosphorus Deficient Areas. *Theiler, Green and du Toit. J. Agri. Sci., XVIII,* 1928, *p.* 369.—The pastures of the Vryburg district of the Cape Province are known to be very deficient in phosphorus. In this paper are recorded the results of experimental work showing that on these arid, sparse, phosphorus-deficient areas grading up of scrub cattle, by combining the introduction of pure bred bulls with the feeding of bone meal (rich in phosphorus) to the cows, is attended with great success so far as shown by the first crossing. Remarkable differences in favour of the mineral supplements are shown. Of 27 cattle dying from "lamsiekte" (phosphorus deficiency) 25 were controls and only two were from batches receiving the small ration of bone meal. Of the cows receiving the bone meal 80 per cent. calved normally. Of the control cows only 51 per cent. calved. The calves from the bone meal fed cows showed a very marked superiority in development over calves from control cows.

DAIRYING.

Bacteria in Pasteurised Milk. *Harding and Ward. J. Bact,* 17 (1) 35.—The non-acid group of bacteria in raw milk are most profoundly affected by pasteurisation in proportion to their numbers, and hence acid-forming bacteria are relatively increased in numbers as a result of pasteurisation. Thermophilic (heat resistant) bacteria are found in practically all samples of raw milk; they increase proportionately during the holding period of pasteurisation—from 1 million per c.c. early in the processing of the milk to many millions after six to eight hours. (These thermophilic bacteria tend to increase the acidity and to affect the flavour of the treated milk.)

Surface Taint in Creamery Butter. *D. B. Shutt. J. Bact.,* 17 (1) 39.—A defect in the flavour of factory-made butter known commonly as "surface taint" has been detected in the produce of many creameries in middle and western Canada, and has caused considerable losses to the makers. This defect is almost unknown in city creameries where the water supplies are known to be pure, but it would appear to be quite prevalent in creameries in rural districts, and more especially after prolonged periods of wet weather. All suspected water supplies were found to be contaminated with the organism *Pseudomonas fluorescens*. Sterile butter when inoculated with this organism and incubated at 25°C. for 28 days, developed typical surface taint. Investigations in the factory and in the laboratory showed that this flavour could be controlled by substitution of pure water for contaminated water for butter washing; subjecting contaminated water to a temperature 190°F. for ten minutes; neutralising the cream to not less than 0·35 per cent. acid.

Effect of High Acid Cream on Fat Content of Buttermilk, and on Churning. *Van Dam and Holwerda. Le Lait,* 9, *No.* 81, *January* 1929.—When the fat in the cream is in equilibrium, a high acidity of the primary cream diminishes the loss of fat in the butter-milk, but has no perceptible effect in the duration of the churning process, but when the fat in the cream is not in equilibrium, i.e., when the cream prior to churning has not been chilled to a low temperature, an acidity exceeding 0·7 per cent. lactic acid prolongs the churning and increases the loss of butter-fat.

Sterilising Creamery Equipment: Use of Hypochlorites. *E. L. Fouts. J. Dairy Science*, 12 (1), 51.—On account of the size of much of the equipment in a creamery or milk depot, it is difficult to employ steam under pressure as a sterilising agent. Chemical sterilization is limited to the use of a few chemicals only. Only such chemicals as have a high bactericidal effect, but which will not impart any injurious effect to milk and its products, and which in addition are non-poisonous, may be employed. Sodium hypochlorite is perhaps the most generally useful agent, but it has the disadvantage of decomposing rather rapidly when put into solution, thereby allowing the active ingredient, chlorine, to escape into the air.

Ordinary washing of equipment, followed by treatment with hot water, does not sterilise, but hypochlorite solutions containing 45 parts active chlorine per million are very effective, and will limit the bacterial increase (from the utensil factor) after pasteurisation to less than 10 per cent.

Preservation of Butter in Vacuum. *S. S. Sevenster, Le Lait*, 8, 78.—According to this investigator, refrigeration alone cannot be depended on to keep butter in perfect condition for more than a few weeks owing to the presence of common moulds like penicillium and oidium and fat splitting bacteria like *B. fluorescens liquefaciens*. The growth of these organisms can be more effectively checked by depriving them of air than by subjecting them to cold. The absence of air prevents the latent oxidation of fats, and facilitates the development of the lactic acid bacteria when a moderate temperature is maintained. The author thinks that the preservation of butter in vacuum offers such advantages as to warrant further study both practically and scientifically.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in December 1928, and January and February 1929.

Live Stock: Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	December.			January.			February.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*Cattle—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ...	65 2	57 9	42 5	63 11	56 8	42 8	62 6	55 9	42 9
Cross-bred (Shorthorn)	58 8	51 3	36 6	57 9	50 8	36 3	57 5	50 7	37 4
Galloway	54 10	50 9	...	54 6	50 5	..	54 5	49 6	...
Ayrshire	53 6	43 3	32 9	53 2	43 0	33 2	52 3	41 9	33 0
Blue Grey	68 0	...	...	...	...	...	...	...	...
Highland	...	...	...	...	...	...	...	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†Veal Calves	16	9	5	16¾	9½	5¾	17	10	6
†Sheep—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	14¾	14¼	10½	14¾	13¾	10	15½	14¼	10½
Half-bred	14	13½	9	14	13	9¼	14½	13½	9½
Blackface	14	13¼	9¾	14	13	9¾	14¾	13¼	10
Greyface	14¼	13½	9¼	14¼	13¼	9¼	14¾	13½	9¾
Down Cross	14¼	13¼	8	14	13	8	14½	13¼	8½
†Pigs—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	11 7	10 2	...	11 11	10 7	...	12 4	11 0	.
Porkers	12 1	10 8	...	12 5	11 0	...	12 10	11 4	...

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets—*continued.*

Description.	December.			January.			February.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK :—									
CATTLE—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head	Per head	Per head.
Aberdeen-Angus :	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	17 9	13 15	12 0	17 6	13 18	12 0	16 15	14 2	13 0
Two-year-olds ...	23 7	19 9	..	23 17	19 11	...	24 0	19 14	...
Cross-bred (Shorthorn):									
Yearlings	15 7	12 3	10 7	15 6	12 2	10 10	15 18	13 2	11 10
Two-year-olds ...	22 0	17 12	12 10	21 10	17 17	...	22 14	18 4	...
Galloway :									
Yearlings	13 7	...	...	12 0	...	...	11 15	...	.
Two-year-olds ...	...	17 0	...	19 0	15 13	...	...	16 5	...
Ayrshire :									
Yearlings	...	...	...	...	...	...	...	...	...
Two-year-olds ...	...	...	...	...	...	...	...	...	..
Highland ·									
Yearlings	...	...	...	...	...	...	...	...	..
Two-year-olds ...	...	...	...	..	...	...	...	...	...
Three-year-olds ...	...	...	...	...	...	...	...	...	...
DAIRY COWS—									
Ayrshire ·									
In Milk	29 15	22 4	12 0	30 13	22 10	12 0	29 10	21 19	12 0
Calvers	29 13	22 2	14 18	29 1	22 1	15 2	30 13	22 2	15 3
Shorthorn Cross :									
In Milk	33 13	23 16	...	34 6	24 16	...	33 5	24 7	21 15
Calvers	31 5	23 7	17 13	30 9	22 7	16 11	29 1	21 9	15 7
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	34 6	...	...	47 6	43 3	...	47 11	37 4	...
Half-bred Hoggs ...	58 9	51 6	40 0	65 8	52 11	41 9	61 1	48 1	40 9
Blackface Hoggs ...	30 0	24 5	...	30 6	24 11	20 6	32 5	26 0	25 0
Greyface Hoggs ...	50 6	43 4	...	47 7	39 0	32 6	49 5	42 3	37 7
Down Cross Hoggs	...	50 3	...	65 0	48 0	30 3	48 0	...	. .
PIGS—									
(6 to 10 weeks old)	24 10	16 8	...	28 8	18 8	...	33 5	23 4	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	Quality.	December. Dundee.	December. Edinburgh.	December. Glasgow.	January. Dundee.	January. Edinburgh.	January. Glasgow.	February. Dundee.	February. Edinburgh.	February. Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF:—										
Home-fed—										
Bullock or Heifer ...	1	8½	8¼	11½	9⅛	8⅞	11⅜	9½	8½	11
	2	7⅞	...	10	8⅜	...	10⅝	8¾	...	10½
Bull	1	7¼	7	7¼	7¾	7⅛	7¼	7¾	7	6¾
	2	6¼	6	6¾	6¾	7	6¾	6¾	6¼	6⅜
Cow	1	6½	5¾	7	6½	6	7	6½	6⅛	6½
	2	5½	5½	6½	5½	...	6½	5½	...	6
Irish—										
Bullock or Heifer ...	1	...	...	8	...	...	8¼	...	...	8¼
	2	...	...	7¾	...	...	7¼	...	...	7¼
Argentine Frozen—										
Hind Quarters ...	1	6⅛	7	5½	6¼	6¾	5½	5⅝	6⅝	5½
	2	5¼	5½	5¼	5¼	5½	5¼	..	5½	5¼
Fore ,, ...	1	5	5	4	5	4⅞	4	4⅞	4¾	4
	2	...	4¾	...	4¾	4¾	...	...	...	...
Argentine Chilled—										
Hind Quarters ...	1	7¼	6⅞	7	6⅞	6¾	6½	6⅝	6¼	6¼
	2	7	6½	6⅝	...	6⅜	6	...	6	5¾
Fore ,, ...	1	5⅛	5⅛	5	5¼	4⅞	5	5	4¾	4⅞
	2	...	4⅝	4½	5	4½	4½	...	4⅝	4⅝
Australian Frozen—										
Hind Quarters ...	1	...	...	5	...	...	5	...	...	5
	2	...	...	4½	...	...	4½	...	...	4½
Crops	1	...	...	4	...	...	4	...	...	4
New Zealand Frozen—										
Hind Quarters ...	1	...	...	5	...	...	5	...	...	5
	2	..	...	4½	...	...	4½	...	...	4½
Fore ,, ...	1	...	...	4	...	...	4	...	...	4
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	12½	10¼	11⅛	12¾	11¾	11⅜	13	11¼	12⅜
	60 lb. & over	12	...	11	12	...	11	12	...	11⅝
,, Cross	under 60 lb.	12⅜	10¼	11½	12¾	11¾	11⅜	13	11¼	12⅜
	60 lb. & over	12	...	11	12	...	11	12	...	11⅝
Ewes, Cheviot	1	...	6¾	8¼	...	7¾	8	...	9	9¼
	2	...	...	7¾	...	...	7½	...	...	8⅜
,, Blackface ...	1	8	6¾	8¼	8⅛	7¾	8	8	9	9⅛
	2	7	...	7¾	7⅛	...	7½	7	...	8⅝
,, Cross	1	7	6¾	7⅜	7	7¾	7½	7	9	8⅛
	2	6	...	6⅞	6	...	7	6	...	7⅝
Argentine Frozen ...	1	...	...	5½	...	...	5½	...	...	5½
	2	...	...	5	...	...	5	...	...	5
Australian ,, ...	1	...	5⅞	5⅛	...	6¼	5½	...	6¼	5½
	2	...	5¼	5	...	5½	5	...	5½	5
New Zealand ,, ...	1	...	..	6	...	...	6	...	...	6*
	2	...	...	5½	...	...	5½	...	...	5½
LAMB:—										
Home-fed	1	...	11⅝	13	...	...	12⅞	...	...	13
	2	...	...	12½	...	...	12⅜	...	...	12½
New Zealand Frozen ...	1	...	10	10½	...	10¼	10½	...	10½	10½
	2	...	...	10	...	...	10	...	10	10
Australian ,, ...	1	...	...	8¾	...	...	8¾	...	...	8⅞
	2	...	...	8½	...	...	8½	...	...	8½
Argentine ,, ...	1	...	...	8	...	...	8	...	...	8
	2	...	...	7¾	...	...	7¾	...	...	7¾

PROVISIONS: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Department's Market Reporter.)

Description.		Quality.	December. s. d.	January. s. d.	February. s. d.
BUTTER:					
Irish Creamery	per cwt.	1	186 0	...	...
,, (Unsalted) ...	,,	1	190 0	...	..
Danish	,,	1	212 6	197 5	197 0
,, (Unsalted) ...	,,	1	216 6	201 5	201 0
New Zealand	,,	1	190 0	194 0	186 3
,, (Unsalted) ...	,,	1	202 0	204 0	195 0
Australian	,,	1	188 3	191 7	187 0
Siberian	,,	1	176 0	...	...
Swedish	,,	1	207 3	195 5	192 0
CHEESE:					
Cheddar	,,	1	124 0	124 1	124 9
		2	116 3	116 0	115 9
Cheddar (Loaf)	,,	1	140 0	138 0	135 6
		2	136 0	134 0	134 0
Dunlop	,,	1	123 0	121 3	122 3
		2	116 0	113 6	111 6
Canadian...	,,	1	116 9	116 7	113 6
New Zealand (Coloured)	,,	1	116 8	105 0	98 9
,, (White)	,,	1	116 6	104 3	97 0
BACON:					
Ayrshire (Rolled) ...	,,	1	123 6	130 0	133 0
Irish (Green)	,,	1	118 0	118 10	131 0
,, (Dried or Smoked)	,,	1	125 6	124 10	136 0
,, (Long Clear) ...	,,	1	112 6	118 0	124 3
Wiltshire (Green) ...	,,	1	117 6	121 2	138 6
,, (Dried or Smoked)	,,	1	125 6	129 2	145 0
Danish Sides	,,	1	109 9	103 0	111 3
Dutch (Green, Wiltshire Style)	,,	1	97 0	93 2	103 3

Description.		Quality.	December. s. d.	January. s. d.	February. s. d.
BACON—*continued.*					
American, Long Clear Middles (Green)	per cwt.	1	95 4	87 5	89 0
American, Short Clear Backs	,,	1	...	..	94 0
HAMS:					
Irish (Smoked)	,,	1	157 0	159 0	172 0
		2	142 0	144 0	157 0
American, Long Cut (Green)	,,	1	116 6	109 2	107 0
American, Short Cut ...	,,	1	114 0	110 10	99 6
EGGS:					
Country	per doz.	1	2 11	2 5	2 2
		2	2 10	2 4	2 1
Irish	per 120.	1	24 9	20 4	19 5
		2	23 11	19 0	17 6
,, (Cold Stored) ...	,,	1	13 5	12 9	12 0
,, (Duck)	,,	1	19 6	...	18 0
Australian	,,	1	20 6	...	...
		2	18 6	...	...
Belgian	,,	1	21 0	18 5	18 11
		2	19 10	17 5	18 2
Canadian	,,	1	16 4	16 0	...
Chinese (Black)	,,	1	12 3	12 0	12 9
,, (Violet)	,,	1	13 4	12 10	13 11
Danish	,,	1	23 8	21 2	...
		2	20 9	..	...
Dutch	,,	1	18 9	16 9	...
,, (Duck)	,,	1	13 0	13 0	...
Swedish	,,	1	23 6	23 0	...
		2	20 9	19 0	...
Polish (Blue) ..	,,	1	12 8	11 10	11 0
,, (Red)	,,	1	11 0	10 6	10 0
Russian	,,	1	14 6	13 7	...
		2	12 2	12 6	...

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Department's Market Reporter.)

Description.		Quality.	December.	January.	February.
FRUIT:—					
Apples—			s. d.	s. d.	s. d.
British—					
Lord Derby...	... per cwt.	1	30 0	...	...
Bramley Seedling ...	,,	1	19 0	...	15 9 ¶
Other Cooking ...	,,	1	18 0	...	...
Other Dessert	... per barrel.*	1	20 0	...	...
Imported—					
American ...	... per case.**	1	12 6	12 3	13 3
Canadian ...	... ,,	1	11 0	10 6	...
Pears—					
Californian ...	... per case.†	1	13 9	14 3	14 10
South African ..	... per box.§	1	...	...	5 6
VEGETABLES:—					
Beet	... per cwt.	1	6 3	7 1	7 9
Brussels Sprouts	... ,,	1	15 6	15 2	12 6
Cabbage, Coleworts	... per doz.	1	...	...	1 0
,, Savoy	... ,,	1	1 11	1 10	1 10
Carrots, *British* ...	... per cwt.	1	5 3	5 2	5 8
,, *Dutch* ..	.. ,,	1	...	.	8 6
Cauliflowers—					
Broccoli, *Cornish*	... per doz.	1	4 10	4 10	4 8
French	... ,,	1	5 0	5 0	4 10
Celery	... per bunch	1	1 11	2 1	1 6
Greens	per 120 heads	1	14 0	14 0	14 0
Leeks	per doz. bunches.	1	3 0	3 0	5 0
Lettuce, *French* ...	... per doz.	1	4 0	4 0	3 10
Onions, *Spring* .	... per bunch.	1	...	...	0 6
,, *Dutch* ...	... per cwt.	1	13 9	13 0	15 10
,, *Valencia*	... per case. ‡	1	15 0	15 11	18 11
Parsley	... per cwt.	1	17 6	19 7	39 0
Parsnips	... ,,	1	8 6	8 0	8 9
Radishes ...	... per doz. bunches.	1	...	...	3 9
Rhubarb	... per cwt.	1	32 0	32 0	40 8
Tomatoes, *Canary*	... per lb.	1	0 6	0 6	0 3
Turnips	... per cwt.	1	2 5	2 2	2 5

* 120 lb. (approx.). ** 40 lb. (approx.). † 42 lb. (approx.). ‡ 9 stone. § 7 lb. ¶ Barrel of 140 lb. (approx.).

POTATOES : Monthly Average Wholesale Prices at Dundee, Edinburgh, and Glasgow.

(*Compiled from Reports received from the Department's Market Reporters.*)

MARKET.		Quality.	LATE VARIETIES. Red Soils. Golden Wonder.	Red Soils. Other.	Other Soils. Golden Wonder.	Other Soils. Other.
			£ s.	£ s.	£ s.	£ s.
			DECEMBER.			
Dundee	per ton.	1	...	...	...	3 6
Edinburgh	,,	1	...	...	...	4 5
Glasgow	,,	1	...	3 18	...	4 15
			JANUARY.			
Dundee	per ton.	1	...	...	...	3 13
Edinburgh	,,	1	...	...	...	4 5
Glasgow	,,	1	...	4 9	..	3 12
			FEBRUARY.			
Dundee	per ton.	1	...	...	...	3 15
Edinburgh	,,	1	...	...	..	4 5
Glasgow	,,	1	...	4 10	8 0	4 9

ROOTS, HAY, STRAW, AND MOSS LITTER : Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(*Compiled from Reports received from the Department's Market Reporters.*)

MARKET.		Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
			s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d	s. d.
			DECEMBER.								
‖ Dundee ...	per ton.	1	...	17 9	25 0	122 6† 112 6‡	...	69 5	...	69 5	50 6*
¶ Edinburgh	,,	1	...	...	...	108 9† 102 6‡	...	55 0	42 6†	50 0	...
‖ Glasgow	,,	1	...	...	...	100 0†	105 0†	60 0	...	65 0	33 2**
			JANUARY.								
‖ Dundee ...	,,	1	...	17 5	21 0	130 0† 120 0‡	...	78 0	...	78 0	57 6 *a*
§ Edinburgh	,,	1	...	...	...	116 6† 109 0‡	...	55 0	...	54 0	...
‖ Glasgow	,,	1	20 0	...	27 6	100 0†	105 0†	60 0	...	65 0	33 10**
			FEBRUARY.								
‖ Dundee ...	,,	1	...	17 8	20 8	135 0† 125 0‡	...	78 9	...	82 6	52 6
§§ Edinburgh	,,	1	...	...	...	117 6† 110 0‡	...	57 6	...	57 6	...
‖ Glasgow	,,	1	...	...	...	100 0†	105 0†	60 0	...	65 0	33 9**

‖ Baled Straw delivered.
¶ Loose Straw delivered.
§ Bunched or loose Straw delivered.
§§ Bunched Straw delivered.

† Delivered baled.
‡ Delivered loose.
a Foreign (delivered in town).

* Foreign (ex quay).
** Home (in 1½ cwt. bales).

Feeding Stuffs : Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	December.		January.		February.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	13 5 0	13 1 3	13 7 0	13 5 0	13 15 0	13 5 0
Foreign	13 6 3	...	13 10 0	...	13 10 0	...
Decorticated Cotton Cake	12 5 0	...	12 7 0	...	12 1 3	...
Undecorticated do.— Bombay (Home-manufactured)...	8 5 0	8 0 0	8 5 0	8 3 4	8 3 9	8 5 0
Egyptian (do.)	8 10 0	8 3 9	8 10 0	8 7 0	8 10 0	8 10 0
Palmnut Kernel Cake	11 5 0	...	11 5 0	...	11 5 0	...
Soya Bean Cake ...	13 10 0	12 1 11	13 10 0	12 4 0	13 10 0	12 6 11
Coconut Cake ...	12 10 0	...	12 10 0	...	12 7 6	...
Groundnut Cake, Undecorticated—						
(37 per cent. Oil and Albuminoids)	10 4 5	10 2 6	10 5 0	10 1 0	10 2 6	10 0 0
(40 per cent. do.)	10 5 0	10 5 0	10 5 0	10 3 9	10 3 9	10 2 6
Maize Germ Cake—						
Home	11 15 0	...	11 19 0	...	12 0 0	...
Foreign	11 18 4	...	11 19 6	...	12 0 0	...
Barley Meal ...	10 10 8	10 17 6	10 9 0	10 11 3	10 12 6	10 11 8
Bean Meal	12 11 11	...	12 12 6	12 0 0	12 13 2	13 0 0
Maize Meal—						
Home Manufactured	11 9 5	11 0 0	11 12 0	11 2 6	11 13 2	11 10 0
South African—						
(Yellow) ...	10 18 2	...	11 1 0	11 0 0	11 7 6	...
(White) ...	10 8 9	...	10 9 0	...	10 10 8	..
Rice Meal	8 15 0	...	8 15 0	...	8 12 6	...
Locust Bean Meal ...	10 5 0	9 12 6	10 5 0	9 15 0	10 5 0	9 15 0
Fish Meal	20 0 0	20 0 0	20 0 0	20 0 0	20 0 0	20 0 0
Maize Gluten Feed (Paisley) ...	10 10 0	..	10 10 0	...	10 10 0	...
Maize—Plate ...	10 6 3	10 5 0	10 14 0	10 8 6	11 0 0	10 14 5
Do. American ...	10 5 0	...	10 7 6	...	10 12 6	...
Do. African Flat	10 8 4	...	10 10 8	...	10 13 4	...
Oats—Home ...	9 4 1	8 10 0	9 10 0	9 1 0	9 16 7	9 0 8
Do. Plate ...	9 1 11	...	9 6 6	...	9 13 9	...
Barley Feeding (Home)	10 18 9	9 10 0	10 19 6	9 11 8	11 0 0	9 11 8
Do. Bran ...	10 4 5	...	10 4 6	...	10 5 0	...
Wheat—						
Home	10 16 3	9 10 0	10 18 0	9 12 6	11 5 0	10 2 6
Poultry	10 0 8	...	10 0 0	9 0 0	10 6 3	10 3 4
Imported... ...	8 17 6	9 0 0	9 6 0	...	9 9 5	...
Middlings (Fine Thirds or Parings)	9 19 5	9 12 6	9 17 0	9 10 0	9 10 0	9 6 11
Sharps (Common Thirds) ...	8 5 0	8 6 3	8 7 6	8 5 0	8 13 9	8 6 3
Bran (Medium) ...	8 6 3	8 0 0	8 14 6	8 1 6	8 18 9	8 8 9
,, (Broad) ...	8 10 0	8 15 0	8 17 0	8 16 6	9 1 3	9 3 9
Malt Culms... ...	8 10 0	...	8 10 0	...	8 6 3	...
Distillery Mixed Grains—Dried	...	9 8 9	...	9 12 0	...	9 15 0
Brewers' Grains—Dried	...	8 7 6	...	8 10 0	...	8 10 8
Distillery Malt Grains—Dried	9 10 0	...	9 5 0	...	9 5 0	...
Crushed Linseed ...	21 0 0	...	21 0 0	..	21 0 0	...
Locust Beans, Kibbled & Stoned	9 10 0	8 17 6	9 10 0	9 0 0	9 10 0	9 0 0
Beans—English ...	12 12 6	...	12 14 0	...	12 15 0	...
Do. China ...	11 8 2	11 12 6	11 11 6	11 13 9	11 [illegible] 8	...
Do. Sicilian ...	11 15 0	...	11 18 0	...	11 6 8	...
Pease—Calcutta (White)	13 12 6	...	13 13 0	...	13 15 0	...
Feeding Treacle ..	7 5 0	7 0 0	7 5 0	7 2 0	7 5 0	7 5 0
	per gallon.	per gallon.	per gallon.	per gallon.	per gallon.	per gallon.
Linseed Oil	0 4 0	...	0 4 0	...	0 4 0	...

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	December. Glasgow.	December. Leith.	January. Glasgow.	January. Leith.	February. Glasgow.	February. Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda § ...	N. 15½	10 5 6	10 8 0	10 7 7	10 8 0	10 10 0	10 9 3
Nitrochalk ‖ ...	N. 15½	...	...	...	9 19 0	...	9 19 6
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	10 7 3	10 6 6	10 10 5	10 9 5	10 18 0	10 10 6
Superphosphate ¶ ...	P.A. 13·7	2 7 6	...	2 7 6	...	2 7 6	...
,, ...	,, ,,	...	2 12 6	...	2 12 6	..	2 12 6
,, ¶ .	,, 16·0	2 12 6	...	2 12 6	...	2 12 6	...
,, ...	,, ,,	..	2 17 6	...	2 17 6	...	2 17 6
,, ¶ . .	,, 17·4	2 17 6	...	2 17 6	...	...	...
,, ...	,, ,,	...	3 2 6	...	3 2 6	...	3 2 6
,, ...	,, 18·3	...	3 5 0	...	3 5 0	...	3 5 0
Ground Mineral Phosphate † ...	P.A. 25½/26	2 7 6	...	2 7 6	...	2 7 6	...
,, ,, ‡ ...	,, ,,	...	...	...	2 7 6	...	2 7 6
,, ,, ‡ ...	,, 34	...	...	...	3 10 0	...	3 10 0
Potassic Mineral Phosphate	P.A. 18, Pot. 5	...	3 5 0	...	3 5 6	...	3 5 0
,, ,,	P.A. 18, Pot. 10	...	3 15 0	...	3 15 0	...	3 15 0
Kainit (in bags) ...	Pot. 14	3 7 6	3 2 6	3 7 6	3 3 0	3 7 6	3 3 9
Potash Salts ...	Pot. 20	3 17 6	3 11 4	3 17 6	3 11 9	3 17 6	3 12 6
,, ,, ...	Pot. 30	5 5 0	4 18 9	5 5 0	4 19 9	5 5 0	5 1 3
Muriate of Potash... (on basis of 80 per cent. purity)	Pot. 50	9 12 6	8 17 6	9 12 6	9 0 6	9 12 6	9 2 6
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 15 0	10 17 6	11 15 0	11 1 0	11 15 0	11 3 9
Steamed Bone Flour	N. 0·8, P.A. 27½/30	6 6 3	6 0 0	6 5 0	6 1 8	6 5 0	6 2 6
Bone Meal, Home ¶	N. 3·29, P.A. 22·9	7 15 0	...	7 15 0	...	...	...
,, ,, Indian ¶	N. 3·75, P.A. 22·9	9 5 0	...	9 5 0	...	9 5 0	...
Basic Slag * ...	P.A. 11	2 1 9	...	2 1 9	...	2 1 9	...
,, ,, * ...	,, 12	2 2 9	...	2 2 9	...	2 2 9	...
,, ,, ** ...	,, 12	...	2 1 6	...	2 1 6	...	...
,, ,, * ...	,, 13	2 3 9	...	2 3 9	...	2 3 9	...
,, ,, ** ...	,, 13	...	2 3 6	...	2 3 6	..	c 1 12 6
,, ,, * ...	,, 14	2 5 9	...	2 5 9	...	2 5 9	...
,, ,, ** ...	,, 14	...	2 5 6	...	2 5 6	...	c 1 14 6
,, ,, * ...	,, 15	2 7 9	...	2 7 9	...	2 7 9	...
,, ,, b ...	,, 16½	...	...	...	3 2 6	...	3 2 6
,, ,, a ...	,, 18	...	3 0 0	..	3 4 6	...	3 7 6

Abbreviations :—N. = nitrogen ; Pot. = Potash ; P.A. = Phosphoric Acid.

* 75 per cent. to 80 per cent Citric Soluble Phosphates ; carriage paid in 6-ton lots to Lanarkshire and Renfrewshire stations. ** Carriage paid in 6-ton lots to Lothians stations.

† Fine grist 80 per cent. fineness through standard 100 mesh sieve.

‡ ,, 85 per cent. ,, ,,

§ Carriage paid in 6-ton lots. ‖ Carriage paid in 2-ton lots. ¶ F.o.r. Glasgow.

a. Belgian slag at Leith. *b.* On rail at Leith. *c.* On rail at Grangemouth.

Printed under the authority of His Majesty's Stationery Office
By J. Skinner & Co., Ltd., Thistle Street, Edinburgh.

(8196.) Wt. 10841/1283. 1500+11, pp. 215-234. 4.29. J.S.&Co.,Ltd. G.18.

The Scottish Journal of Agriculture.

VOL. XII.—No. 3.] JULY 1929. PRICE 1s. NET.

DISTRIBUTION OF LIVE STOCK IN SCOTLAND.

FIFTY YEARS' CHANGES.

Sir ROBERT GREIG, M.C., LL.D., and J. S. KING, B.Sc. (Agr.), Ph.D. (Econ.), N.D.A.

DURING the past fifty years the live-stock population of Scotland has remained fairly stationary. Comparing the official statistics for the periods 1871-75 and 1924-28, the number of horses of all ages is only 0·3 per cent. greater, of cattle 6·3 per cent. greater, and of sheep 1·4 per cent. greater. The numerical increases represented by these percentage changes are—

	Increase.
Horses	482
Cattle	70,580
Sheep	97,911
Pigs	11,970

These increases, although not without significance, are not big enough to suggest any very important change in the character of the live stock industry in Scotland. When, however, we go behind the totals to the figures for the various districts, it is found that there have been changes of considerable magnitude and importance.

Source and Nature of Data.—Statistics of live stock and crops in Scotland have been collected over a long series of years : from 1866 to 1911 by the Privy Council and by the (then) Board of Agriculture and Fisheries, and since 1912 by the Department of Agriculture for Scotland. These figures, published annually in the official "Agricultural Statistics," are compiled from returns received from farmers relating to a date early in June each year. The live stock data thus give a picture of farming stocks during the period of summer grazing. The ewe flocks have finished lambing and, except in a few forward districts, the full crops of lambs are still on the farms where they were bred. Where flying flocks of breeding sheep are kept, the ewes, destined for the butcher before another crop of lambs is taken, are still running with their lambs, and are enumerated as "sheep over one year old," but not as breeding ewes. Ewe hoggs, wintered on the

lower pastures, will be back on the hills. The late wethers not finished on turnips on the lowland farms, or kept for a second season on the hills, will be counted in. In June the figures relating to cattle will, as in the case of the sheep, tend to show stocks at their maximum numbers in the breeding areas. In the grazing districts, too, where Scottish or Irish stores are summered on grass, the maximum numbers might be expected to be on the farms in June. In the arable areas devoted mainly to growing saleable crops, however, where dungmaking in yards involves the wintering of cattle, the ratio of winter to summer stocks would be greater than in the breeding and grazing districts.

Pig stocks may be expected to be higher in the summer than in the winter months, particularly in the areas where whey from cheesemaking finds an outlet in the fattening of store pigs.

Horses in most areas tend to remain at a fairly uniform number throughout the year.

We shall not, except by inference, be able to obtain a statistical picture of the seasonal fluctuations of stocks as the natural summer pastures give place to the rotation grass, and the autumn and winter forage crops of the arable lands are brought into use. The seasonal drift will be, in the main, from the higher to the lower lands—from the north and west to the south and east.

It is our present purpose to indicate the considerable changes in the composition of flocks and herds during the past fifty years, not indeed as a slowly changing picture as year succeeds year, but by taking a jump back to the early seventies and measuring the cumulative effects of change.

It appears that, generally speaking, the rate of change has been greater since 1910-14 than in the earlier period, but the general direction of change has been the same.

General Character of the Changes in Stocking.—Bearing these facts in mind the recorded June figures for 1871-75 and 1924-28 are now examined.

The first impression created by Table I is that instead of similarity in the positions fifty years ago and at the present time, as might be suggested from the aggregate figures, we are in the presence of changes of considerable importance.

Reference in detail to *Horses* has been omitted as the basis of classification has been changed since the earlier statistics were collected, and comparisons cannot be made over a long period with certainty. Moreover, horses are, speaking generally, part of the farm equipment rather than agricultural products for sale to non-agricultural users. They have, however, been brought into account in computing the percentage change in live stock units.

In *Cattle* stocks significant but unequal changes are manifest. The greatest absolute increases in cattle are recorded in the dairying counties, Ayr, Kirkcudbright, Wigtown, Dumfries, and also in Aberdeen. In Aberdeen, however, the addition of 12,000 head represents only a gain of 8 per cent. Smaller, but nevertheless important, increases occur in the Border counties, Berwick, Roxburgh and Selkirk, whilst the greatest proportional gain

TABLE I.

Increases and Decreases in Live Stock—by Counties—1871-75 and 1924-28, with Per Cent. increases in the area under Grass and the Extent of Mountain and Heath Grazings.

County.	Cattle. + = Increase. − = Decrease.		Sheep. + = Increase. − = Decrease.		Pigs. + = Increase. − = Decrease.		Live Stock Units.	Rotation and Permanent Grass.	Area of Mountain and Heath Grazings per acre of cultivated land.
	No.	per cent.	No.	per cent.	No.	per cent.	per cent.	per cent.	acres.
Aberdeen	+12,541	+ 8	+132,735	+93	+9,710	+ 86	+17·9	+25	0·3
Angus	− 2,403	− 5	+ 67,514	+55	+ 673	+ 10	+ 9·0	+14	0·8
Argyll	− 7,415	−12	−307,728	−29	− 567	− 11	−24·0	+30	12·2
Ayr	+17,974	+20	+ 6,623	+ 2	−2,797	− 17	+13·0	+ 9	1·1
Banff	− 171	− ½	+ 31,788	+65	+1,140	+ 26	+ 8·5	+17	0·4
Berwick	+ 7,357	+45	+ 98,889	+37	− 96	− 2	+33·0	+33	0·4
Bute	+ 1,073	+14	− 332	− ½	− 94	− 12	+ 8·0	+24	2·7
Caithness	− 1,178	− 6	+ 61,273	+60	− 138	− 7	+19·5	+29	2·7
Clackmannan	− 276	− 7	+ 1,483	+13	− 786	− 45	− 3·0	+38	0·7
Dumbarton	− 434	− 3	− 6,478	− 8½	+ 133	+ 11	− 5·0	+17	1·9
Dumfries	+14,215	+26	+ 64,590	+13	−4,953	− 31	+16·0	+38	1·6
East Lothian	+ 5,739	+74	+ 41,758	+40	+1,443	+ 45	+43·0	+24	0·4
Fife	+ 4,705	+12	+ 55,696	+80	+1,381	+ 20	+21·0	+30	0·1
Inverness	− 3,094	− 6	−236,530	−34	−2,256	− 51	−24·0	+68	10·9
Kincardine	− 2,380	− 8½	+ 29,522	+91	+ 734	+ 26	+ 6·0	+15	0·4
Kinross	− 571	− 8½	+ 4,639	+16	+ 141	+ 19	+ 0·25	+10	0·4
Kirkcudbright	+17,656	+44	+ 1,276	No change	+5,703	+ 73	+18·5	+26	1·9
Lanark	+ 4,107	+ 6	+ 22,817	+10	−1,110	− 12	+ 7·5	+10	0·9
Midlothian	− 1,441	− 8	+ 16,121	+10	+8,338	+156	+ 4·6	+ 1	0·7
Moray	− 234	− 1	− 5,369	−10	+ 57	+ 1	− 2·7	+15	1·0
Nairn	+ 584	+10	− 3,044	−17	− 170	− 18	+ 3·0	+14	2·1
Orkney	+ 6,552	+26	+ 9,768	+32	−2,708	− 57	+22·0	+41	0·6
Peebles	+ 357	+ 5	+ 12,329	+ 6	− 272	− 27	+ 5·3	+82	3·3
Perth	−14,979	−18	− 46,779	− 7	−1,068	− 10	−11·8	+18	2·7
Renfrew	− 1,042	− 4	+ 3,538	+ 9	+1,329	+ 60	− 1·1	+ 3	0·5
Ross and Cromarty	− 246	− ½	− 62,009	−17	−2,788	− 42	−10·0	+61	7·7
Roxburgh	+ 6,390	+37	+ 68,595	+14	− 552	− 13	+16·8	+37	1·3
Selkirk	+ 1,284	+50	+ 21,871	+13	+ 124	+ 27	+16·0	+70	4·8
Shetland	−10,318	−47	+ 62,553	+70	−4,758	− 95	− 8·2	−57	12·5
Stirling	+ 2,147	+ 7	+ 2,868	+ 2	+ 402	+ 16	+ 5·0	+28	1·3
Sutherland	− 2,316	−19	− 22,596	−10	− 783	− 54	−12·5	+84	32·0
West Lothian	− 437	− 4	+ 1,187	+ 6	+ 107	+ 6	− 0·5	+10	0·1
Wigtown	+17,182	+43	− 4,780	− 4	+5,889	+ 61	+27·0	+34	0·8

(74 per cent.) occurs in East Lothian. Orkney has added considerably to its cattle stocks, but in the other districts showing gains, Fife, Lanark, Stirling and Bute, the changes are not great in proportion to total stock.

The area in which the greatest losses in cattle stocks are recorded is Perth, and, in contrast to the gain in Orkney, Shetland has now only about one-half of the cattle carried in 1871-75. Argyll, Inverness, Caithness and Sutherland have fewer cattle, though the losses are not large in proportion to total stock, and rather curiously, perhaps, Angus and Kincardine also show decreases in opposition to the reverse tendency observed in Fife and Aberdeen. Mid and West Lothian too have fewer cattle in contrast with the large increase in East Lothian. It will be necessary to look at these changes more closely if their causes and significance are to be suggested. It will, however, be convenient to turn first to sheep and pigs to obtain a view of the combined tendencies with all classes of stock before going into more detail.

In the case of *Sheep* gains and losses in different areas have been even more striking. Whilst cattle have increased most notably in the south-western area, the most significant development of sheep has been in the eastern counties, including the Orkneys and Shetlands. In Aberdeen and Kincardine sheep stocks have almost doubled; in Shetland, Fife, Banff, Caithness, Angus, sheep are more than 50 per cent. greater, and East Lothian shares the general gain. Even in the Border counties, including Dumfries, which already in the seventies were well stocked with sheep, considerable increases are recorded. The dairying districts of the south-west do not show any very appreciable change. Heavy *decreases* in sheep appear in Argyll, Inverness, Ross and Cromarty, and Sutherland, in particular in the two first-named counties. Argyll still remains the leading sheep county, but Inverness has ceded second place to Perth, which, however, has also lost sheep, and both Roxburgh and Dumfries now have larger flocks in the summer than Inverness.

Pigs occupy a comparatively unimportant place in Scottish agriculture, but considerable changes in the distribution of the pig population are observed. The number of pigs may show considerable fluctuation from year to year, but the five year averages for 1871-75 and 1924-28 are worthy of note. Aberdeen records the greatest increase and displaces Ayrshire as the most important pig-feeding area. Midlothian has two and a half times as many pigs as it had 50 years ago, and is third only to Wigtown in the pig industry in Scotland. Wigtown has, together with Kirkcudbright, considerably increased its stocks, whilst Dumfries and Ayr show important reductions. As the pig is typically the small farmer's beast, it is of interest to note this reduction in Ayrshire as well as the heavy decrease in the crofting counties of Inverness, Ross and Cromarty, Orkney and Sutherland. In Shetland and in Skye the pig has, for all practical purposes, disappeared.

A very approximate indication of the aggregate changes in live stock of all kinds can be obtained by expressing each class of stock in terms of "live stock units." A fairly common standard is to consider a mature horse or cattle beast as equivalent to seven mature sheep or to five pigs, with young stock in a similar ratio. On this basis, the percentage changes in live stock units for each county have been calculated, and are given in Table I. The areas which show the greatest percentage losses in live stock units are Argyll and Inverness. Considerable decreases also occur in Sutherland, Perth and Ross and Cromarty. These areas, in fact, now carry a smaller number of stock of each class. Shetland also carries less total stock, but in this case more sheep are some compensation for fewer cattle and pigs. The areas in which the greatest percentage gains are recorded are the East Coast and border counties—East Lothian, Berwick, Orkney, Fife, Caithness, Aberdeen, Roxburgh and Selkirk, and the dairying areas of the south-west—Wigtown, Kirkcudbright, Dumfries and Ayr. The gains have not been uniform, and it will be necessary to examine the changes rather more closely.

Losses of Stock in Highland Districts.—One striking fact, however, emerges, that the decrease in the numbers of live stock units is greatest in the Highland districts in which there are large areas of mountain and heath grazings. The largest gains occur in the lowland and arable areas of the east and in the districts in the south-west now devoted to dairying. Caithness, Selkirk, Dumfries, Kirkcudbright and Roxburgh, in all of which gains are recorded, also have considerable areas of mountain and heath grazing, but they are, generally speaking, at a lower elevation than the areas where the greatest losses occur. In Caithness the gains are entirely due to sheep, in Selkirk, Roxburgh, Kirkcudbright and Dumfries, mainly to cattle.

Speaking broadly, there has been a change in the distribution of summer stock affecting, in a negative sense, the higher mountain grazing areas, and in a positive sense the maritime counties of the east, the Border area, and the counties of the south-west. The position is summarised in the following table :—

TABLE II.

Period.	Counties of Argyll, Inverness, Ross and Cromarty, Sutherland, and Perth.			Remainder of Scotland.		
Average of:	Cattle.	Sheep.	Pigs.	Cattle.	Sheep.	Pigs.
1871-75	246,524	3,082,712	28,263	880,813	4,078,409	137,885
1924-28	218,136	2,383,224	20,860	979,781	4,875,808	157,258
	- 28,388 or 11·5% decrease.	- 699,488 or 22·7% decrease.	- 7,403 or 26 2% decrease.	+ 98,968 or 11·2% increase.	+ 797,399 or 19·5% increase.	+ 19,373 or 14% increase.

It would thus appear that there have been losses of all classes of stock, particularly of sheep, on the higher lands, and that these losses have been more than compensated by gains of stock of all classes on the lower lands.

It is important to examine the adaptations in the management of the cultivated area which have accompanied the changes in stocking.

The Stocking of Grass Lands.—Examination of the changes in the cultivation of the land would reveal that in all areas there has been a considerable reduction in straw crops and in green crops for forage. The Northern Isles alone provide an exception to that general truth, Shetland having extended the area under forage crops. Almost universally there has been a lengthening of the rotation, the only exceptions being in Ayrshire, Lanark and Renfrew, where in 1871-75 grass was left down from six to nine years, in Stirling and in West Lothian. In addition the area under permanent grass has been extended, either at the expense of the arable area or by the improvement of rough pasture. The percentage increases of grass land in relation to the percentage increase or decrease in live stock units and the extent of the area under mountain grazing in each county are worthy of consideration. In Aberdeen, Dumfries, Inverness, Kirkcudbright, Peebles, Ross and Cromarty, Selkirk, Stirling, Sutherland and Wigtown the increase in permanent grass can be accounted for by the taking in of rough grazings. In several of these cases, where gains of live stock units are recorded (see Table I), they are small in proportion to the increase of cultivated grass, but it is also to be observed that in the majority of the remaining areas, where the grass has been extended entirely at the expense of the arable and cropped land, the live stock carried in June have not increased in proportion to the area of grazing available. The only exceptions to this statement are East and Mid Lothian, Ayr and Shetland. If it may be assumed that grassland improvement has been effected on any considerable proportion of grazings, the inference would be justified that much of the added grass is of comparatively poor quality, or that by lengthening the rotation the average quality of the rotation grasses has deteriorated. In those areas where a considerable increase in cultivated grass land has been accompanied by a *fall* in total stock carried, viz. in the highland areas referred to in Table II, it must clearly be the case that it is from the rough grazings that the stock have, in the main, been lost.

Various explanations have been offered for the diminished stocking of the hill areas. It is suggested that they have deteriorated owing to over-stocking, which has resulted in the loss of mineral constituents carried away in the flesh and wool of the stock, or to the increase of bracken and of blaeberries; or again that the increase of sheep at the expense of cattle during the past century meant a ruinous selective grazing which destroyed the plant population available for food. It is a relevant fact that

during the period under review there has been a considerable extension of deer forests. Between 1883 and 1920 the increase in the deer forest area amounted to nearly a million and a half acres. A Departmental Committee which reported in 1921 attributed the extension between 1892 and 1912 mainly to economic causes—"the fall in the value of sheep and wool, the difficulty in finding tenants for sheep farms, and the heavy loss incurred in respect of sheep stock taken over by proprietors, which they could not afford to hold. The underlying cause was the adoption in the eighteenth century of an agricultural system in the Highlands which was almost entirely dependent on the price of sheep." Further, "In some cases the sporting tenant offered a rent higher than any farmer could afford to pay." . . . "Unless leased to sporting tenants, or stocked under a Government guarantee, they would in some cases have remained derelict." (Cmd. 1636, p. 27.) Deeper rooted causes are suggested here, and it will be possible to throw some light upon these from a further analysis of the statistics, coupled with some reference to the course of prices.

Changes in Sheep Stocks.—(a) *Increase in Ewe Flocks.*—Since sheep are of primary importance in the Scottish live stock economy, we propose to deal with them first. The Statistics for 1871-75 are not as complete as those collected more recently, and the earlier figures merely distinguish sheep under one year old from older sheep. It is, however, possible to estimate approximately the size of the ewe flocks in 1871-75 from the number of lambs, if we may assume that the ratios of ewes to lambs surviving in June will not be greatly different at the two periods. These ratios for 1921-25 are given in Table III, column 3. Owing to the development of the use of cross-bred ewes in the lowland areas it may be that a rather greater proportion of ewes to lambs would have been found in these districts fifty years ago, but we may, by not regarding as significant computed gains which are less than say 20 per cent. of the estimated number of ewes in 1871-75, use the computed size of the flocks with safety. Table III shows the results of this calculation and the estimated changes in the ewe flocks in the Scottish counties. These have been arranged according to the magnitude of the increase of the ewe flocks.

It is apparent that all along the eastern side of Scotland, not excluding Orkney and Shetland, there have been substantial increases in ewe flocks in the past fifty years. The tendencies indicated in Table III were in force before the war, and have been operative since. In Shetland, however, the recorded flocks were rather greater in 1910-14 than in 1921-25. Actual *decreases* in ewes occur in Argyll, Inverness, and possibly in Ross and Dumbarton. In Ayr, Moray and Nairn the flocks have not been appreciably enlarged, but in other areas gains, though less imposing than in the east, are significant. The potential output of lambs is 20 per cent. greater for the whole of Scotland; it is more than 100 per cent. greater in the east; it is considerably increased

TABLE III.

1. County.	2. Ewes and Rams. 1924-28.	3. Fall of Lambs. 1924-28.	4. Calculated No. of Ewes and Rams. 1871-75.	5. Calculated increase in Ewe Flocks.	6. Per cent. Change in Ewes and Rams.
		Per cent.			
Aberdeen	110,261	116	33,000	+77,300	+235
Kincardine	26,885	112	8,100	+18,800	+232
Fife	48,670	127	18,500	+30,200	+163
Angus	78,538	110	31,300	+47,200	+151
Banff	33,639	109	15,200	+18,400	+121
Caithness	70,095	104	32,700	+37,400	+114
East Lothian ...	55,314	127	30,300	+25,000	+ 82
Berwick	139,098	137	80,000	+59,100	+ 74
West Lothian ...	7,448	127	4,300	+ 3,100	+ 72
Kinross	14,354	108	9,100	+ 5,300	+ 58
Shetland	73,747	69	46,500	+27,200	+ 58
Orkney	16,567	120	11,700	+ 4,900	+ 42
Clackmannan ...	6,038	97	4,500	+ 1,500	+ 33
Dumfries	259,049	97	203,000	+56,000	+ 28
Lanark	107,161	95	84,000	+23,200	+ 28
Midlothian	70,715	116	55,300	+15,400	+ 28
Renfrew	19,104	93	15,000	+ 4,100	+ 27
Roxburgh	230,584	116	184,000	+46,600	+ 25
Kirkcudbright ...	171,793	97	140,000	+31,800	+ 23
Sutherland	89,640	83	72,800	+16,800	+ 23
Perth	293,688	85	244,000	+49,700	+ 20
Peebles	95,469	97	80,000	+15,500	+ 19
Selkirk	87,401	97	75,000	+12,400	+ 16½
Stirling	57,061	90	49,800	+ 7,300	+ 15
Moray	22,288	99	20,200	+ 2,100	+ 10
Wigtown	58,584	97	53,600	+ 5,000	+ 9½
Nairn	5,960	89	5,500	+ 500	+ 9
Ayr	174,672	90	161,000	+13,700	+ 8½
Bute...	19,608	78	18,400	+ 1,200	+ 6½
Dumbarton	33,197	81	32,000	+ 1,200	+ 4
Ross and Cromarty	134,565	81	130,000	+ 4,600	+ 3½
Inverness	245,050	73	286,000	−41,000	− 14
Argyll	366,701	69	444,000	−77,300	− 17½

on the southern uplands. Only on the higher hills is it seen to have diminished.

(b) *Decrease of Wether Sheep.*—From the calculated size of the ewe flocks in 1871-75 we can, by deduction, arrive at the numbers of other sheep over a year old, and compare these with the corresponding numbers at the present time. Here a very different story is revealed. The sheep population in 1921-25 over a year old other than breeding ewes is found, in most areas, to be between one-third and one-quarter of the number of ewes, and must consist in the main of gimmers, ewe hoggs and draft ewes. In a few districts the proportion of older sheep is greater than can be accounted for as young breeding stock, viz. in the Lothians and Nairn, where flying flocks of ewes will be fattening with their lambs, and in Inverness, Ross and Cromarty, Sutherland and Shetland, where there will be a number of wethers. But the position fifty years ago was in strong contrast. In 1871-75, in nearly every county in Scotland, the number of sheep over one year old, other than ewes and rams, was approximately *double* the present number. As ewe flocks were smaller, the number of ewe hoggs and gimmers would be less. Thus the greater proportion of the older sheep would be wethers kept for mutton and for wool. These have in considerable measure disappeared. The greatest absolute losses of these older sheep, exceeding 80,000 in each case, have occurred in Argyll, Perth and Inverness; the decreases exceed 40,000 wether sheep in Roxburgh, Dumfries, Kirkcudbright, Ross and Cromarty, Sutherland and Ayr. In Berwick the loss is almost as great. The greatest percentage losses (exceeding 60 per cent.) are estimated to have occurred in Inverness, Argyll and Perth, but the fall in wether sheep is common for the whole country. In only one instance, viz. in Shetland, is a converse tendency to be noted. Here, no doubt, the substitution of sheep for cattle already noted in Table 1, the relatively low rate of growth of the stock and the demand for Shetland wool have contributed to this result.

It may be of interest to assess the relative extent of the combined changes in the stocks of ewes and wethers in the various districts. This can be measured by estimating what number of "other sheep over one year" would have been carried in 1871-75 had the present proportion been operative then, and deducting this number from the number then carried. The difference is then divided by the size of the ewe flock in 1871-75. Measured in this way, the greatest change is found to have occurred in Aberdeen, where there has been a loss of 1·8 wethers per ewe. A similar rate of change occurs in West Lothian, but here the sheep are relatively few. Next in order of degree of change are Kincardine (1·7), Angus (1·5), Fife (1·2), Kinross (0·8), East Lothian (0·8), Berwick (0·7), a sequence which follows the map from north to south, and suggests a relatively greater change of emphasis in favour of the output of younger sheep as one travels northward. West and north of Aberdeen the changes are less marked. Here the influence of the hill

grazings is more pronounced, but the degree of change is still considerable. In the south-western area the sheep policy has changed less markedly. In Ayr the index of change is only 0·1, in Bute 0·2, in Wigtown, Lanark, Dumbarton, Dumfries 0·3, Kirkcudbright 0·5. This does not imply that more older sheep are kept in these areas, but rather that the numbers were relatively fewer fifty years ago than in the feeding areas of the north-east. In the great Blackface sheep-breeding county, Argyll, the index of change of policy (0·3) is for a similar reason comparatively small, although the numbers involved are very large. It is greater in Inverness, Perth and Ross and Cromarty (0·6), Sutherland (0·8). In some of these areas mixed tendencies accompany a rather considerable variation in physical conditions. In the Border areas there is evidence of relatively little change, in Selkirk the index being less than 0·1 of a wether sheep per ewe, in Roxburgh and Peebles less than 0·3. Enquiry has elicited the fact that as far back as the seventies a trade in lambs for the London market direct from the Border hills had developed, and relatively few wethers were maintained.

Economic Tendencies.—The tendencies thus measured give some concreteness to the recognised adaptations of the Scottish flocks to the demand for smaller mutton, and it may be that here is to be sought a potent cause for the facts observed. We propose to examine briefly some of the data relating to prices.

(a) *The Fall in Value of Wethers.*—In the *Transactions of the Highland and Agricultural Society of Scotland* are quoted the prices of Cheviot and Blackface sheep and of wool since 1818. The prices of wethers, ewes and lambs respectively have been averaged for each period of five years from 1871 for comparison with one another. To avoid complications due to changes in the general level of prices, the prices of wethers and of lambs have been expressed as percentages of the price of ewes for each period. The results are given in Table IV below.

TABLE IV.

Ewes=100.

	Cheviot Sheep.		Blackface Sheep.	
	Wethers.	Lambs.	Wethers.	Lambs.
1871–75	142	53	166	66
1876–80	151	65	162	79
1881–85	123	50	164	66
1886–90	144	64	157	73
1891–95	137	54	162	61
1896–1900	116	53	142	52
1901–05	117	57	133	54
1906–10	119	61	123	58
1911–15	114	66	116	62
1916–20	113	65	113	68
1921–25	66	60	91	58
1926–27	84	Ewe lambs. 86, Wether lambs. 62 } 1924–27	87	Ewe lambs. 70, Wether lambs. 76 } 1926–27

During the period under review, and in particular since the 1880's, there has been a progressive fall in the selling prices of Cheviot wether sheep as compared with the value of ewes. Some reaction seems to be taking place in 1926-27, but its extent cannot yet be gauged. Lambs have maintained their proportional value, but there is evidence of considerable disparity between the values of Cheviot ewe and wether lambs. With Blackfaces the same general tendencies are observed, although the falling off in comparative value of wethers occurs later, and the comparison is less favourable throughout to ewes than is the case with Cheviots. In recent quotations there is not the same evidence of disparity in the values of Blackface ewe and wether lambs.

There seems to be clear evidence here that lower values of wether sheep must have been a cause contributing to the reduction in their numbers. This reduction reflects not so much a decrease in output of sheep as the younger age at which they are sold. It is noted, for example, that in Argyll an estimated reduction of 17½ per cent. in ewes is accompanied by a reduction of 61 per cent. in other stock over one year old, and other cases are similar.

There is further evidence of the change in size and age of wether sheep marketed. This is given in Table V below.

TABLE V.

Period.	1. Average Price of Cheviot Wethers.		2. Average Price of Blackface Wethers.		3. Average Price of Mutton per 8 lb. stone.[1]	4. Approximate Weight of Wethers sold. Cheviot.	5. Approximate Weight of Wethers sold. Blackface
	s.	*d.*	*s.*	*d.*	pence.	lbs.	lbs.
1871-75	43	10	32	9	63	67	49
1876-80	42	0	33	4	61	66	52
1881-85	42	0	36	6	61	66	57
1886-90	35	7	29	3	53	64	53
1891-95	30	11	28	2	48	62	56
1896-1900	30	5	28	4	48	61	56
1901-05	30	1	28	6	52	55	52
1906-10	30	7	26	4	54½	53	46
1911-15	34	1	30	2	60	54	48
1916-20	57	7	50	1	121	46	40
1921-25	50	2	51	10	...	...	...

The estimates of weight given in columns 4 and 5 are arrived at by dividing the values of wether sheep in columns 1 and 2 by the price per lb. of mutton in column 3. The estimates may be subject to correction to express the carcase weight accurately, but they are at any rate comparable from period to period. It

[1] Report of Committee on Stabilisation of Agricultural Prices. (Ministry of Agriculture Econ. Series, No. 2.)

would seem that the smaller Blackface sheep did not begin to find a market at a still smaller weight until the larger breed had made some progress down the scale. But there is clear evidence here of the consistent reduction in weight of hill sheep marketed for mutton.

(b) *Course of Wool Prices*.—A further reason which would contribute to the unpopularity of the wether sheep was the unfavourable course of wool prices.

The average price of white Cheviot wool 1871-75 is reported to be about 36*s*. 1*d*. per stone of 24 lbs.; the average price of a Cheviot ewe during the same period was 30*s*. 10*d*.

In the period 1901-05 the price of wool had fallen by 50 per cent. to 18*s*., the price of a ewe had declined by only 15 per cent. to 25*s*. 10*d*. In the period 1921-25 wool had risen 80 per cent. to 33*s*. 7*d*., but the price of a ewe was now 75*s*. 10*d*.—an increase of nearly 200 per cent.

The prices of Blackface wool similarly had fluctuated, though not in the same degree, in an unsatisfactory ratio compared with the prices of ewes.

With reduced incomes from the wethers as meat and also from their wool, and with greater demands from the lower farms for hill ewes for crossing, there would seem to be strong economic pressure in co-operation and any other causes of a physical nature making for the depopulation of the higher and rougher lands capable of carrying only the wether flocks. Where better grazing was available, or could be obtained at the expense of corn growing on the arable lands, larger numbers of ewes were brought in to produce a more rapid turnover of fat lambs. In the poorer areas the grazing needs of the lambs, brought on more rapidly for earlier slaughter or sale for crossing, may well have restricted the ewe-carrying capacity of the lower grazings. In the Highland areas there is, moreover, a difficulty in finding wintering for the ewes and lambs. It is a question of economic balance which the farmer solves rather by intimate contact with his land and stock than by precise calculation.

Changes in Cattle Stocks.—Turning now to cattle, we are faced with a somewhat similar general phenomenon as in the case of sheep, though it is less marked in its intensiveness. In the aggregate cows and heifers have increased from approximately 392,000 to 455,000, i.e. by 16 per cent. Young cattle are also in larger numbers, 515,000 in 1924-28 against 467,000 in 1871-75—an increase of 10 per cent. Non-breeding cattle of two years of age and upwards have fallen from 268,000 to 237,000, i.e. by 11 per cent. The cattle question in Scotland, however, unlike that relating to sheep, is not purely an internal one: roughly, one half of the cattle fattened are purchased as stores from Ireland. Whilst our breeding flocks have been given over to producing ewes for crossing and fat lambs for the butcher, our breeding herds are, in the main, increasing for the specialised function of milk production. A large share of the business of producing young cattle for feeding is left in other hands. Even

in those districts which have been the home of cattle rearing and feeding, breeding herds show no increase, whilst ewe flocks are multiplying; in other areas cattle are grazed chiefly for the purpose of keeping the grass in good condition for sheep; in the arable areas they are kept and wintered mainly for the production of dung and only incidentally for meat. These impressions are illustrated in Table VI.

The Development of Dairying.—In Ayrshire cows account in the main for the increase in the cattle stocks of the county. The relative increase is greatest in Kirkcudbright, where cow stocks have doubled. Important, though smaller, increases are registered over the whole of the counties supplying the industrial area of Scotland. A sheltered home market, large industrial populations north and south, and natural conditions favourable to grass are the key to this development. This movement was already strongly marked before the war period.

In the dairying districts the increase in ewe stocks has not kept pace with the growth in number of cows, to accommodate which Ayrshire has extended its permanent grass, partly at the expense of corn crops and partly by reducing the area under rotation grasses. The high ratio of rotation grasses to green fodder crops indicates a rather specialised form of grass husbandry in this area. Kirkcudbright has added to its permanent pasture and doubled the length of its grass leys. Dumfries and Wigtown have proceeded, but less rapidly, along the same lines as Kirkcudbright.

It is not possible, from the statistics, to distinguish clearly between dairy cattle and other breeding stocks. There has been some development of dairying in Aberdeen, Fife and elsewhere, but the ratios in which stocks of cows and other cattle are held indicate that along the eastern coastal belt, as one travels from north to south, rearing is replaced by feeding, a phenomenon observed also in the case of sheep, and that dairying has not made any great headway. (See Table VI.) In this table the presence of dairying or breeding is suggested by a relatively small proportion of calves to cows, and a progressive falling off in the proportion of yearlings and two-year-olds kept for the maintenance of the herds. Examples are seen in the figures for Ayr and Wigtown, also in Argyll, Inverness and Sutherland. Where Ayrshire cows are kept the calves not required for rearing for the herd will be slaughtered young. Where rearing is practised more calves are kept, and the number of yearlings may be in excess of the number of calves owing to purchases from the breeding districts, whilst the number of two-year-olds falls off by the sale of stores. This position is shown in Aberdeen, Banff and Kinross. Where cattle are fattened on the grass lands, the number of two-year-olds may exceed the number of yearlings by the purchase of stores from other districts or from Ireland. This condition appears strongly in East Lothian, Angus and, to a less marked degree, in Midlothian, West Lothian, Clackmannan, Selkirk and Stirling. In Berwick it appears that cattle,

TABLE VI.

County.	Cows and Heifers.			Number of "Other Cattle" per 100 head of Breeding Cattle, 1921-28.		
	1871-75.	1924-28.	Per cent. Change.	Above 2 years.	Yearlings.	Calves.
Aberdeen	44,116	43,681	- 1·0	91	109	83
Angus	12,028	12,093	+ 0·5	128	89	61
Argyll	22,975	21,586	- 6·0	38	48	57
Ayr	44,746	59,629	+33·3	15	29	32
Banff	13,269	12,598	- 5·1	47	98	87
Berwick	3,612	4,324	+19·7	169	171	72
Bute	3,093	3,540	+14·5	32	51	54
Caithness	7,573	6,903	- 8·9	30	75	78
Clackmannan ...	1,167	1,358	+16·4	64	54	36
Dumbarton... ...	6,193	7,417	+19·8	22	25	23
Dumfries	16,562	26,873	+62·2	35	54	54
East Lothian ...	1,978	2,958	+49·5	176	104	53
Fife	8,578	12,858	+50·0	94	81	52
Inverness	20,236	20,648	+ 2·0	22	42	58
Kincardine... ...	7,082	6,663	- 5·9	91	111	79
Kinross	1,119	1,564	+39·8	74	137	68
Kirkcudbright ...	11,918	23,752	+99·2	39	53	43
Lanark	33,663	39,622	+17·7	20	25	26
Midlothian... ...	9,164	9,149	- 0·2	33	31	18
Moray	7,250	6,675	- 7·9	60	104	76
Nairn	1,782	2,203	+23·6	24	77	85
Orkney	9,347	10,554	+12 9	38	84	79
Peebles	2,019	2,389	+18·3	49	74	54
Perth	21,058	18,378	-12·7	72	101	80
Renfrew	14,492	15,961	+10 1	13	20	18
Ross and Cromarty	16,459	17,330	+ 5·3	26	47	49
Roxburgh	4,604	5,926	+28·8	115	101	65
Selkirk	852	1,355	+59·0	41	70	61
Shetland	8,516	5,637	-33·8	22	38	42
Stirling	9,550	12,534	+31·4	56	55	37
Sutherland... ...	5,397	4,778	-11·5	17	41	43
West Lothian ...	3,571	5,449	+52·3	41	32	26
Wigtown	18,288	29,062	+58·9	27	31	33

to augment home-reared calves, are bought as yearlings and kept for a second summer.

Rearing and Feeding.—Reference to Table VII reveals in some measure the changes in the emphasis upon rearing and feeding during the past fifty years. There has been a notable decrease in the maintenance of two-year-old cattle in the hill-grazing areas—Argyll, Inverness, Perth, Sutherland. In Ayr, Dumfries, Kirkcudbright, they are giving way to younger cattle, as might be anticipated with the growth of dairying. The only areas in which there is any marked growth in the number of older cattle is in the Border areas—Berwick and Roxburgh, and in East Lothian, where it would seem that forward cattle are brought in or kept for finishing on the pastures. Otherwise, the general decrease in cattle over two years old corresponds with a similar movement in wether sheep, although the decrease has not reached the same proportions. The available statistics do not permit of comparison between the numbers of calves in the two periods under review. The totals of "other cattle" under two years can, however, be compared. Their increase is in a slightly lower ratio than the increase in cows and heifers. Having regard to the considerable volume of the import of Irish stores, which include calves and yearlings as well as older cattle, it would seem that the development of the production of "baby beef" has not received the same stimulus as the fat lamb trade, but in the north-eastern feeding areas more young cattle are being purchased, and sales are made, on the average, at a younger age. In Moray, Angus, Kincardine, East Lothian and Berwick, on the other hand, there is rather more emphasis on older cattle in summer in comparison with younger stock than formerly. In Roxburgh, Selkirk and Peebles the general increase of cattle has affected mainly the classes under two years old.

To sum up briefly the impressions as to the redistribution of non-breeding cattle stocks, it may be said that in the dairying districts a natural increase in young dairy stock is observed corresponding to the development of the milking herds. Other breeding cattle have been moving from the Highland areas to the lower hills. In the important breeding and feeding areas, breeding stocks have hardly maintained their position in face of the competition of ewes, and cattle are being sold at a rather lower age. There is a general decline in older feeding cattle, the heavier beasts showing a tendency to drift towards the arable areas of the south-east, doubtless as grazing beasts to be finished on grass after wintering on straw and turnips for the making of manure, or to keep the pastures in condition for the more important grazing of sheep.

In the case of cattle it is not possible to apply the same tests as to the economic stimulus to change as were available with sheep. The test of relative profitableness is not possible in the absence of accounts and of prices of cattle of varying weight and grade. Moreover, the cattle are, in some areas, complementary to the ewe flocks. No problem of stock carrying capacity, how-

TABLE VII.

Numbers of other Cattle—1871-75 and 1924-28.

County.	2 years of age and above. 1871–75.	2 years of age and above. 1924–28.	Per cent. Change.	Under 2 years of age. 1871–75.	Under 2 years of age. 1924–28.	Per cent. Change.
	No.	No.	Per cent.	No.	No.	Per cent.
Aberdeen	40,152	42,787	+ 6·6	76,538	86,878	+13·5
Angus	16,661	16,476	− 1·1	21,068	18,786	−10·8
Argyll	16,541	9,497	− 42·6	22,574	23,592	+ 4·5
Ayr	14,518	11,666	− 19·6	31,211	37,254	+19·4
Banff	7,698	6,554	− 14·9	22,502	24,148	+ 7·3
Berwick	4,550	8,049	+ 77·0	8,056	11,203	+39·1
Bute	1,638	1,365	− 16·7	3,015	3,914	+29·9
Caithness	3,350	2,260	− 32·5	10,259	10,843	+ 5·7
Clackmannan ...	1,349	951	− 29·5	1,339	1,269	− 5·2
Dumbarton... ...	2,972	2,012	− 32·3	4,466	3,770	−15·6
Dumfries	13,982	11,084	− 20·7	23,636	30,439	+28·8
East Lothian ...	2,715	5,657	+108·3	3,072	4,888	+59·1
Fife	14,183	13,200	− 6·9	16,442	17,851	+ 8·6
Inverness	8,610	5,210	− 39·5	21,247	21,140	− 0·5
Kincardine	7,040	6,585	− 6·5	14,613	13,108	−10·3
Kinross	2,122	1,302	− 38·7	3,565	3,367	− 5·6
Kirkcudbright ...	12,325	10,542	− 14·4	15,983	23,587	+47·5
Lanark	11,380	9,862	− 13·3	21,325	20,991	− 1·6
Midlothian	4,274	3,321	− 22·3	5,063	4,589	− 9·4
Moray	4,010	4,448	+ 10·9	12,589	12,492	− 0·8
Nairn	1,028	664	− 35·4	3,230	3,759	+16·4
Orkney	3,602	4,206	+ 16·8	12,314	17,256	+40·1
Peebles	1,612	1,373	− 14·8	3,002	3,227	+ 7·5
Perth	22,893	14,666	− 35·9	38,866	34,789	−10·5
Renfrew	4,046	2,637	− 34·8	7,392	6,289	−14·9
Ross and Cromarty	8,522	5,009	− 41·1	14,504	16,900	+16·5
Roxburgh	5,275	7,524	+ 42·6	7,534	14,353	+90·5
Selkirk	687	649	− 5·5	1,045	1,864	+78·4
Shetland	6,824	1,318	− 80·6	6,491	4,559	−29·8
Stirling	9,380	8,002	− 14·8	11,481	12,020	+ 4·7
Sutherland	2,120	878	− 58·5	4,528	4,071	−10·1
West Lothian ...	4,015	2,529	− 37·1	4,153	3,324	−20·0
Wigtown	7,846	9,143	+ 16·5	14,060	19,170	+36·5

ever, arises in the hill grazing areas with respect to cattle. Agricultural opinion favours the view that a better balance between cattle and sheep would make for improvement of these grazings. The key to change is to be sought in the balance of advantage, tested by the usual empirical methods open to the farmer, and measured by adequate books of account over a series of years.

During the past fifty years changes of considerable moment in Scottish live stock economy have thus taken place. Various factors may have contributed to these changes, and so far as they affect the stocking of hill pastures, deterioration due to bracken, to loss of mineral constituents or to unbalanced grazing, have been reinforced by the pressure of economic forces. It is not possible to assess the proportional responsibility of these factors, but the strong pull of prices against the maintenance of wether flocks has been demonstrated. The whole story reflects the adaptability of Scottish farming to changing conditions.

The MANURIAL REQUIREMENTS of SOILS.

TWO MODERN METHODS of ESTIMATION.

R. Stewart, B.Sc.,

Soils Department, Edinburgh and East of Scotland College of Agriculture.

In this country the only methods in use for the estimation of the manurial requirements of soils, apart from field experiments, depend on chemical analysis of the soil. All work of this nature is subject to considerable uncertainty since the chemical factors determining the availability of the soil nutrients have not been completely elucidated. The ordinary citric acid extraction method depends on the rather indefinite correlation which has been experimentally found in certain cases between the results of the analyses and the results of field experiments. Even this method gives only an estimate of the available potash and phosphoric acid, and there is no satisfactory method for the determination of the nitrogen requirements of soils.

Within the last few years two methods of estimating the manurial requirements of soils have been introduced in Germany, and the interest they have aroused, together with the magnitude of their practical application, would suggest that a short account of these methods may be of interest to agriculturists in this country. Both methods have been developed as a result of purely academic scientific investigations, and are an example of what may result from work of this nature.

The methods resemble each other in so far as they are a departure from the more usual purely chemical methods of soil examination, and depend on the plant itself for an indication of the amount of available plant nutrients. Professor Mitscherlich, Director of the Plant Growth Institute of the University of Königsberg and one of Germany's foremost agricultural

chemists, having decided that the existing chemical methods did not give sufficient information regarding the state of fertility of the soil, turned his attention to the study of the laws of plant growth, and the results of his researches have led to the development of a very interesting method of soil examination. The second and more recent method is due to Professor Neubauer, Director of the State Agricultural Experiment Station at Dresden, and is based on the absorption of soluble plant nutrients by young seedlings. Since Mitscherlich's method is of more fundamental scientific importance it is proposed first to give an account of his work and conclude with a description of the simpler Neubauer method, although this is of equal importance from the practical standpoint.

MITSCHERLICH'S POT CULTURE METHOD.

Theories underlying the Method.—Previous to Mitscherlich's work most of the attempts made to explain the effect of a manure on the growth of a plant were based on what is known as the "law of the minimum." This law stated that the yield of a field was governed by the manurial constituent which was relatively most deficient in the soil, and that no increase in yield could be obtained unless this constituent was present in the applied dressing. For example, if a soil was very poor in nitrogen and relatively rich in potash and phosphoric acid it was thought that no increase in yield could be obtained unless nitrogen was present in the applied dressing. Mitscherlich believes, on the other hand, that each manurial constituent affects the growth of the plant independently of the others, although the absolute value of the effect depends on the quantities of the other constituents present in the soil.

By a long series of pot cultures extending over many years Mitscherlich has been able to show that the yield of a plant measured by the quantity of dry matter produced increases in a definite way with the addition of increasing quantities of a manure or other factor affecting the growth of a plant. It was found that the rate of increase in yield was not proportional to the quantity of manure applied, but decreased with increasing additions of manure until a point was reached where no further increase in yield could be obtained. It was also found that this maximum yield was obtained always from the same quantity of manure no matter how the other constituents were varied. By this it is not meant that the absolute maximum yield was constant, but that the maximum yield obtained by increasing one constituent was always obtained from the same quantity of this manure.

Mitscherlich also found that the effect of any given quantity of manure is constant provided this "effect" is measured in a certain manner. He compares the yield of dry matter obtained with the value of the maximum yield as defined above, and the ratio of these two quantities, which is a measure of the

" effect " of the given quantity of manure, is found to be constant, although the actual value of the increase in yield will vary under different conditions of experiment.

It should be mentioned that these conclusions were derived from experiments in sand cultures, but it was found that exactly the same laws applied to experiments with soils, except that the effect produced was partly due to the applied manure and partly to the manure present in the soil and available to the plant. Mitscherlich also claims that this effect is quite constant under all conditions of growth and for all agricultural crops. This is the most important point in the application of Mitscherlich's laws to soil examination, and it must be admitted that there is still much controversy in Germany regarding the validity of his theories. Certain evidence has been obtained that the effect of potash manuring is not invariably constant, but it can be shown that the observed discrepancies do not affect the practical application to any appreciable extent.

The basis of the application of the above laws to soil examination lies, therefore, in the fact that Mitscherlich has determined the quantitative relationship between the crop yield and the concentration of manure producing it, and in the fact that this relationship is constant under all conditions of growth. The value of the crop produced under certain conditions is measured, and from the result the quantity of available manure which produced it can be deduced. Since the quantity of manure which will give the maximum yield is also known it follows that a reliable estimate of the manurial deficiency in the soil is obtained. Once this is known it is possible to calculate the most profitable application for that particular soil, i.e. the quantity of manure which will give the greatest return per unit of cost.

This method of soil examination has certain advantages possessed by no other method in use at present, but it is costly and slow, and, as previously mentioned, has been subjected to considerable criticism, which unfortunately has not always been impersonal. From the evidence so far available it is difficult to assess the true value of much of the criticism, but the method has found such extensive practical application that it is worthy of serious consideration.

Details of Method.—For practical advisory purposes the soil examination is carried out by means of pot experiments in central stations specially equipped for this type of work. For each soil sample examined a series of 20 pots was formerly required, but the method has been modified and 16 are now used for the determination of the available potash, phosphoric acid and nitrogen in the soil. The four manurial treatments, each in quadruplicate, consist of—(1) complete manure, i.e. potash, phosphoric acid and nitrogen; (2) complete minus nitrogen; (3) complete minus phosphoric acid, and (4) complete minus potash. The quantities of manures comprising the complete dressing are sufficient to give the maximum yield which can be obtained from potash and phosphate manuring.

The experimental pots, of a special pattern designed by Professor Mitscherlich, contain about 13 lbs. of a one to one mixture of soil and sand. The sand is added for two reasons: (1) to improve the physical condition of the soil, and (2) to act as a dilutant. Owing to the fact that the pots must be watered every second day for a large part of the growing season, there is a danger that heavy soils may cake and form cracks which prevent the thorough moistening of the soil. This risk is greatly lessened when sand is used. It has been found that some soils contain more than sufficient available potash and phosphoric acid to give maximum growth, and the dilution with sand allows the correct figure to be obtained from these soils.

After the addition of the appropriate manures 50 oat seeds are planted in each pot, but after germination this number is reduced to 35. The pots are placed on banks in a large wire netting enclosure, and the oat crop is grown to maturity. Particular care is taken that the pots of each series are kept at the same moisture content. This is done at first by weighing each pot and bringing the contents to a definite fraction of the water-holding capacity of the soil-sand mixture. When the plants have grown to such an extent that there is a difference in weight between the pots in the different treatments the water content is gradually increased until all the pots are at full water capacity, and this condition is maintained throughout the full growing season. Shortly before harvesting the watering is discontinued in order to hasten the ripening of the grain. The grain and straw are harvested separately, and the corresponding weight of dry matter determined by drying at 100° C. From the results so obtained it is possible to calculate how much potash, phosphoric acid and nitrogen was present originally in the soil in a state available to the plant, and hence a definite and quantitative estimate is obtained of the state of fertility of the soil.

Although Mitscherlich has used his theory to form the basis of a system of field experiments in which small plots take the place of the previously mentioned pots, the method has been most extensively used in Germany for pot cultures, which have certain obvious advantages over even the best regulated field trials. This introduces, however, a disadvantage which is common to all pot culture work, namely, the difficulty in obtaining a sample of soil which will be truly representative of the field from which it is taken. Mitscherlich uses for his pot work soil sampled from the top 8 inches of the field, but the subsoil below this may have a very marked effect on the growth of the crop. As the result of experiment Mitscherlich has found the effect of the subsoil is equivalent on the average to doubling the quantity of available nutrient present in the surface soil. He therefore uses this factor in all his advisory work with pot cultures. It must be emphasised, however, that this is one of the main weaknesses of this method, as the factor 2 is only an average and has been found to vary within fairly wide limits.

As an indication of the agreement between pot and field

experiments we may take the following examples given by Mitscherlich in his book *Die Bestimmung des Düngerbedürfnisses des Bodens* (The Estimation of the Manurial Requirement of the Soil). The first example is a manurial experiment carried out at Willkühnen in 1922 to determine the yields obtained from a series of treatments in which various dressings of ammonium sulphate were applied both to the field plots and to the pots. In Table I under the columns headed "X" are given the quantities of ammonium sulphate applied, while the yields are given under the columns headed "Y."

TABLE I.

(*a*) Field Experiment with Potatoes.			Pot Experiment with Oats.				
			(*b*) Grain Yield.			(*c*) Total (Grain and Straw) Yield.	
X. cwt./acre.	Y found. cwt./acre.	Y calculated.	X. cwt./acre	Y found. cwt./acre.	Y calculated.	Y found.	Y calculated.
0·00	115·4±1·5	115·9	0·00	51·8±1·1	52·2	118·4±2·0	117·9
1·62	123·0±1·7	126·6	2·10	63·9±1·7	66·3	140·2±3·2	141·9
4·05	143·9±1·1	140·5	5·26	86·3±1·4	83·8	175·4±1·1	172·0
6·48	147·3±2·3	152·3	13·15	113·9±1·8	113·9	222·0±2·9	223·2

It will be noticed that there is general agreement between the actual yields and the values calculated from Mitscherlich's equations. From the field experiments with potatoes it can be calculated that the soil previous to cropping contained 10·9 cwt. per acre of ammonium sulphate or the equivalent amount of available nitrogen. From the pot experiments it was found that the quantity of available nitrogen was equivalent to 7·3 cwt. per acre sulphate of ammonia. In this case under actual field conditions the quantity of available nitrogen was only about 1½ times greater than the quantity in the surface soil as sampled for the pot experiments.

The results from a similar experiment carried out at Bulitten are given in Table II.

TABLE II.

(*a*) Field Experiment with Potatoes.			Pot Experiment with Oats.				
			(*b*) Grain Yield.			(*c*) Total (Grain and Straw) Yield.	
X. cwt./acre.	Y found. cwt./acre.	Y calculated.	X. cwt./acre.	Y found. cwt./acre.	Y calculated.	Y found.	Y calculated.
0·00	135·5±2·6	141·4	0·00	78·9±0·6	78·9	168·6±1·2	168·5
1·62	145·0±3·7	144·2	2·10	86·8±0·9	87·1	185·8±1·9	184·4
4·05	148·9±3·9	148·7	5·26	98·9±1·9	97·2	211·2±5·1	204·4
6·48	150·4±3·9	152·0	13·15	108·1±2·8	114·5	237·3±4·8	238·2

Good agreement is again observed between the actual and calculated yields. In the field experiments the quantity of avail-

able nitrogen as calculated from the results is found to be equivalent to 25·1 cwt. per acre of sulphate of ammonia; while from the pot experiments it is found to be 12·7 cwt. per acre. In this case the total quantity available in the field is almost exactly twice that present in the surface soil, and this is in agreement with Mitscherlich's practice of doubling the quantities deduced from his pot experiments.

Practical Application.—In order that the East Prussian farmers should have the opportunity of having their soils tested by this method, Professor Mitscherlich in 1923 founded a Society which is known as the "Mitscherlich-Gesellschaft." The Society was composed of some of the larger farmers and landowners in the district, who subscribed sufficient capital in the form of founders' shares for the installation of the equipment necessary to carry out the method on a large scale. Each £10 share in the Society entitled the holder to have examined one soil sample per year for five years at a reduced rate. The original charge was £6 per sample, but this has now been reduced to £3, 5*s*. for holders of founders' shares and to £5 for non-shareholders. From these figures it is seen that the method is costly, but that it has proved of value to the farmers is shown by the rapid development of the Society even under these terms.

It may be of interest to quote a few clauses in the Articles of Association of the Society:—

> "(1) The Society exists for the purpose of furthering the use of artificial manures on the basis of the results of scientific investigation.
>
> "(2) Membership of the Society is open to any farmer or any person interested in advancing the aims of the Society. Admission to membership is decided by the committee of the Society on its own judgment, although the committee can transfer this power of admission to specified persons.
>
> "(3) Members of the Society are pledged to follow the decisions of the committee and the resolutions passed at the Society meetings, and in particular to pay the annual subscription and charges which may be fixed from time to time."

The first of the Society's pot experiment stations was erected at Königsberg in the grounds of the Pflanzenbau-Institut of the University, of which Institute Professor Mitscherlich is Director. The installation consists of a large wire netting enclosure in which the pots are arranged in double rows on stands about 2 feet high and about 4 feet apart. The station when built had a capacity of 2,400 pots, but in the following year (1924) it was found necessary to increase the size of the station to 3,800 pots. In the spring of 1925 it was found necessary to extend the scope of the operations of the Society to other parts of East Prussia, and branch stations were erected at various agricultural centres, Insterburg, Preussich-Holland, and Osterode. This was still not sufficient to meet the growing demands of the farmers, and in

the spring of 1927 a large station was erected at Marienburg in West Prussia, and a second station was built at Königsberg in the grounds of the experimental farm of the "Pflanzenbau-Institut" at Lawsken-Juditten. The station at Marienburg was erected with the financial assistance of the Government on the condition that preferential consideration would be given to the requirements of the small farmer.

The following is therefore a complete list of the stations run by the Society with the number of pots in use at each :—

Königsberg	3,800	pots	(1923)
Insterburg	2,000	,,	(1925)
Pr. Holland	2,000	,,	(1925)
Osterode	2,000	,,	(1925)
Marienburg	6,000	,,	(1927)
Lawsken-Juditten	3,000	,,	(1927)

This gives a total of 18,800 pots used by the Society. The firm responsible for their manufacture have supplied altogether 56,000 pots, of which 53,000 are used in various parts of Germany by the Mitscherlich-Gesellschaft and similar organisations, as well as by the numerous research departments of the Universities and Agricultural Institutes. In contrast to these figures the total number of Mitscherlich pots in Britain is 308, 60 being at Rothamsted, 188 in the Edinburgh and East of Scotland College of Agriculture, and 60 at the North of Scotland College of Agriculture.

The size and nature of a Mitscherlich Station are illustrated by photograph No. 1, which shows the largest station situated at Marienburg in West Prussia. Practically all the 6,000 pots are being used for advisory soil examination work.

Photograph No. 2 shows a typical soil series after about six weeks' growth.

Pot No. 76 received the complete dressing, i.e. nitrogen, potash and phosphoric acid.

Pot No. 72 the same dressing with the omission of phosphoric acid.

Pot No. 68 ,, ,, ,, potash.

Pot No. 64 ,, ,, ,, nitrogen.

This particular soil shows, therefore, a marked deficiency in nitrogen and phosphoric acid but a fairly plentiful supply of potash.

Results obtained in East Prussia.—The number of soil samples examined by the Society in the various years since its institution were as follows :—

Year 1923	93 soils.
,, 1924	153 ,,
,, 1925	290 ,,
,, 1926	355 ,,
,, 1927	673 ,,

In 1927 the results obtained showed that only 4 per cent. of the soils contained sufficient nitrogen reserves to justify the omission of this manure from the next year's dressing. Fifty per cent. of the soils contained sufficient potash for at least one year's crop, and 43 per cent. contained sufficient phosphoric acid. It is, therefore, evident that in the districts of East Prussia served by the Society the great majority of the soils were deficient in nitrogen, but that potash and phosphoric acid were already present in the soil in sufficient quantity to give maximum growth in about 40 per cent. to 50 per cent. of the soils examined.

Since the quantities of artificial manures which a farmer can apply are limited by the factor of cost, it is not economically possible always to give those dressings which would produce the maximum yields, and Mitscherlich recognises this fact in making his recommendations for manurial treatment. An example of the type of recommendation sent out by the Society is given below in Table III, which has been translated from the German, and in which the quantities are given as cwt. per acre.

TABLE III.

Recommendation of the "Mitscherlich-Gesellschaft."

Station.................. ....

Soil sample from...

Field...

	To obtain the maximum yield in practice the soil should contain the following quantities of manures.	The soil in the year 19.... contained the following quantities of manures.	The soil should receive now or next spring the following manurial dressings.
Pure Potash	1·6 cwt. per acre.	1·5 cwt. per acre.	0·4 cwt. per acre.
=40 % Potash Salt	4·0 " "	3·8 " "	1 " "
Pure Phosphoric Acid	1 8 " "	2·7 " "	...
=Supers or Basic Slag	10·5 " "	15·8 " "	...
Pure Nitrogen	4·9 " "	1·2 " "	0·4 cwt. per acre.
=Sulphate of Ammonia	24·0 " "	6·1 " "	2·0 " "

Remarks.

Potash manuring.—Replace every year the potash extracted by previous year's crop.

Phosphate manuring.—Omit phosphates from dressing for one or two years, then replace the yearly loss.

Nitrogen manuring.—Forced manuring, i.e. increase as much as is economically possible.

It will be noticed that Mitscherlich states that the maximum yield will be obtained from any soil which contains the given quantities of potash, phosphoric acid and nitrogen. This may

No. 1

No. 2

seem at first to be contrary to practical experience, but it is one of the conclusions derived from his laws of plant growth.

In the particular case given above the soil is seen to be well supplied with potash and to have a plentiful supply of phosphoric acid, while the nitrogen content is very low. Mitscherlich, therefore, recommends that in this case most attention should be paid to increasing the available nitrogen supply by heavy dressings of nitrogenous artificials and by increasing the soils content of organic matter by dunging and green manuring.

In this country it is the practice to recommend " balanced " manurial dressings for particular crops. Mitscherlich, however, trys to obtain a somewhat similar balance *in the soil itself* by combining the quantities of essential manures *already available in the soil* with the appropriate additions of artificials, and he believes that the same balance is required for all crops. When an attempt is made to obtain a " balance " in the applied dressings it is usually forgotten that this may be completely upset when the available nutrients in the soil are taken into account. Mitscherlich has found that very large variations in the quantities of available potash, phosphoric acid and nitrogen occur in different soils. For example, in the soils in East Prussia he has found the available nitrogen content to vary from the equivalent of about 1 cwt. per acre ammonium sulphate up to the extremely high value of about 65 cwt. per acre. For potash the corresponding quantities have varied between ½ cwt. per acre and about 16 cwt. per acre of 40 per cent. potash salt. For phosphate manures the variations have been found to lie between the equivalent of about ½ cwt. per acre and about 30 cwt. per acre of basic slag. When these facts are borne in mind it will be seen that Mitscherlich is justified in recommending that less attention be paid to " balance " in the dressings and more attention paid to the problem of obtaining the proper balance in the soil itself.

Pot Method of detecting Soil Acidity or Alkalinity.—Professor Mitscherlich also makes use of a pot method to determine whether a soil is sufficiently sour or acid to require liming. The method is only qualitative. No measurements of crop yield are made, and the information desired is obtained from a visual examination of the progress of growth. Eight pots are required for each soil sample and these are divided into two series of four, which receive an alkaline and an acid manurial dressing respectively. Duplicate pots in the alkaline and acid series are sown with oats and white mustard. Oats do not grow well in an alkaline medium nor mustard in an acid medium.. If therefore the oats grow better in the pots receiving an alkaline dressing it indicates that the soil is in need of lime, or at least that alkaline artificials should be used in preference to those having an acid reaction.

The method is probably of most value in those cases where other tests such as determination of actual acidity (of pH) or " lime requirement " show only weak acidity, and for which the interpretation of these values is especially difficult. For

some soils with a pH in the region of 6·0 to 6·5 an application of alkaline artificials such as Chile saltpetre and basic slag may be sufficient to counteract the slight acidity, and Professor Mitscherlich's method is a useful indication in these cases.

NEUBAUER'S SEEDLING METHOD.

Professor Neubauer has recently been using a method of estimating the manurial requirements of soils which is both simpler and cheaper than the Mitscherlich method, although not of such fundamental importance. The Neubauer method, as it is now generally known in Germany, is based on the rapid absorption of soluble plant foodstuffs by young seedlings. By growing a large number of rye seedlings in a small quantity of soil Neubauer found that there were considerable differences in the quantities of potash and phosphoric acid extracted by the seedlings from different soils. He assumes, therefore, that this quantity of "root-soluble" nutrient is a measure of the state of fertility of the soil, and has developed a method of practical soil examination on this basis.

Details of Method.—The practical details of this method are as follows. The soil samples sent in by the farmers are laid out on shelves to dry and then passed through a 2 mm. sieve. 100 gms. of dry sieved soil are placed on the bottom of a cylindrical glass dish 7 cms. high and 11 cms. in diameter and mixed with 50 gms. of a coarse, pure quartz sand. On top of this are placed 250 gms. of fine, pure glass sand, moistened with 80 ccs. of water. A glass tube is inserted in the centre of the dish to facilitate watering of the soil, and 100 rye seeds, previously weighed and soaked in a disinfecting solution, are planted individually in the surface layer of sand. The pots are weighed and covered with a flat glass plate and left in a room kept at a constant temperature of 20° C. until germination has taken place and the shoots are touching the cover glass. This is now removed, and the seedlings are allowed to grow for 17 days from the date of sowing. During this period the moisture content of the soil-sand mixture is maintained at a constant value. For the first ten days this value is 80 ccs. per pot, but on the eleventh day this is increased to 100 ccs.

On the eighteenth day the shoots are harvested, and the total organic matter, i.e. shoots and roots, is collected by washing away the soil and sand. The organic matter is carefully ashed at a low temperature and the ash is analysed for potash and phosphoric acid by the usual chemical methods. In order to determine how much of the potash and phosphoric acid found in the ash was originally present in the rye itself blank experiments are carried out in the same manner except that 100 gms. fine sand replaces the soil.

It is found that under these conditions the seedlings absorb from 4 to 50 milligrams K_2O and from 0 to 15 milligrams P_2O_5 from 100 gms. dry soil. Neubauer has calculated the quantities

of these nutrients which should be absorbed from a soil capable of giving a high value yield of various crops. The average values of those "limiting values," as Neubauer has called them, are 24 milligrams K_2O and 6·0 milligrams P_2O_5. On comparing the results of the analyses with those values it is possible to obtain an indication of the manurial requirements of the various soil samples. Professor Roemer of Halle has checked Neubauer's limiting-values by comparison with field trials and has obtained fairly general agreement.

The charge made to the farmers for soil analysis by this method is at present 20 marks, approximately £1, but last year (1928) the German State and Free State Saxony Governments advanced grants to Professor Neubauer which would enable the charge to be reduced to 6 marks. It is not intended to make this full reduction at present, as a part of the grant will be applied to further research on the method.

The Neubauer method, owing to its comparative simplicity and cheapness, has attracted great attention in Germany, although it was only introduced in 1923. .Since that year over 100 articles have appeared in the German agricultural magazines containing criticisms of the method and the results of practical experience when compared with older methods or with field trials. The technique of the method has been extensively criticised as the values obtained undoubtedly depend on the analytical conditions such as variety and grain size of rye seed, temperature, and moisture content of the soil-sand mixture. In general, however, it seems that the method can be sufficiently standardised to give results which are of considerable value to the farmer.

Some Results obtained by the Method in Germany.—Neubauer has published a summary of the results obtained by him since 1924 from about 1,000 soil samples obtained mainly from the Free State Saxony. The table of results is given below :—

mg. K_2O per 100 gms. dry soil.	Percentage of soils.	mg. P_2O_5.	Percentage of soils.	The foodstuff supply is :
Up to 20	49	Up to 4	54	Too small.
20 to 30	36	4 to 6	23	Sufficient.
30 to 40	10	6 to 8	13	Good.
Over 40	5	Over 8	10	Very good.

From these results it is seen that approximately half of the soils were deficient in potash or phosphoric acid. It will not be necessary to emphasise the importance to the farmer of information of this nature. No correlation has been found in the above instance between the origin and nature of the soil and its manurial requirements.

Professor Roemer of Halle has investigated about 720 soils by the Neubauer method and compared the values obtained with

the results of field experiments. He has found agreement between the two methods for potash in about 75 per cent. of the soils and about 80 per cent. with reference to phosphoric acid. It should be pointed out that in the cases where there was no agreement between the results the error is just as likely to lie with the field experiments as with the Neubauer method, since the results of a single year field trial can sometimes be very misleading.

In conclusion it may be stated that while both Mitscherlich's and Neubauer's methods of soil examination have found extensive practical application in Germany, it must not be considered that either is infallible. Both have been extensively criticised, Mitscherlich's mainly on theoretical grounds and Neubauer's mainly on details in technique, and it is quite possible that further research may result in the discovery of simpler, and perhaps more accurate, methods of soil examination. Until better methods are available, however, it might be advantageous to employ such methods as those described in order to obtain some estimate of the amounts of fertilisers which ought to be applied.

RECENT ACTS OF PARLIAMENT.

Agricultural Produce (Grading and Marketing) Act, 1928.— This Act, which became law on 3rd August 1928, applies equally to Scotland and to England and Wales. It consists of two main parts, one applying generally to the grading and marketing of produce, and the other containing special provisions as to eggs.

Descriptions of quality have long been freely used by producers and retailers of food of various kinds, but so far these descriptions have had no precise meaning and no official sanction. The object of the new Act is to provide official designations on which the purchaser may rely as indicating definite grades. The adoption of these designations is voluntary, but if a designation is applied to an article it will be deemed to be a term of the contract of sale that the quality of the article accords with the definition indicated by the designation.

The Department of Agriculture have power to make regulations prescribing " grade designations " indicating the qualities of any kind of agricultural or horticultural produce, and also providing appropriate marks (" grade designation marks ") for indicating these qualities.

The commodities so far dealt with by the Department are eggs and tomatoes. Having consulted the various interests involved, the Department made on 17th January last Regulations for the Grading and Marketing of Eggs.

The " grade designations " are three in number— " Specials," " Standards " and " Mediums," and refer solely to the weight of the eggs, the minimum ranging from 17 lb. to 14 lb. per 120, with a small permissible deviation in each case. No

distinction of actual quality is made; all the eggs included in the various grades must be fresh, unpreserved, clean and sound.

The "grade designation mark" or "national mark" that is the guarantee of quality consists of a map of Scotland in silhouette bordered on the left by a Union Jack and on the right by the Cross of St. Andrew, with the words "Produce of Scotland" and "Empire Buying begins at Home." This mark is printed on labels to be placed on cases or cartons of eggs, the three grades being distinguished by colour.

Persons desiring to take advantage of this scheme must be registered by the Department, and on registration each receives a distinctive number. No unauthorised person may use the national mark. Many packers have already been registered, and the actual operation of the scheme began on 1st June.

The Regulations regarding tomatoes were made on 17th April. Here there are four "grade designations" according to size, ranging from "Large AA," 4-6 fruits to 1 lb., to "Small AA," 13-16 fruits to 1 lb. The necessary standard of quality is the same in all cases, 5 per cent. by count of any package being allowed to be under that standard.

A leaflet describing each scheme has been prepared for issue to the public.

The second part of the Act deals with "marking" of a different kind. Under the grading scheme the eggs themselves are not marked in any way; the guarantee is given by the mark placed on the case or carton. This part of the Act provides for the individual marking of eggs preserved by cold or chemical methods, whether these eggs are home-produced or imported. The Department have, however, made an Order exempting eggs preserved in cold storage from this provision, as they are empowered to do by the Act. The duty of enforcing the regulations regarding the marking of eggs rests with the County Councils and Town Councils, which are to keep registers of premises used for the storage of eggs.

The Agricultural Credits (Scotland) Act, 1929.—This Act, which became law on 27th March and came into force on 1st April, is in two parts, dealing respectively with long-term and short-term credits.

Part I closely resembles Part I of the corresponding Act applying to England and Wales, which was passed some months earlier, but its financial scale is that appropriate to the smaller needs of Scotland. It is proposed that a company should be incorporated for the purpose of (1) making loans on heritable security over agricultural land; (2) making loans under the Lands Improvements Acts, 1864 and 1899, for agricultural purposes. The former purpose was fulfilled for a time by Section 1 of the Agricultural Credits Act, 1923, which enabled the Public Works Loan Commissioners to make loans to farmers who had purchased their holdings between 5th April 1917 and 27th June 1921, and which was in force until 31st July 1928. Of that scheme 160

Scottish farmers took advantage, the total amount borrowed being £544,000.

Under the new scheme a company is to be formed with a capital of £250,000, half of which will be contributed by the Department of Agriculture for Scotland, free of interest for a period of sixty years. The Department will also pay £1,750 per annum for ten years towards the cost of the company's administration. The interest on the remaining £125,000 of capital is limited to 5 per cent. Thus the Government's annual contribution for the first ten years is £8,000 (£6,250 interest for year foregone + £1,750), and for the next fifty years £6,250. Debentures are to be issued in order to raise the money necessary, in addition to the capital, for the making of loans, and the Treasury may take up one-fourth of each issue, up to a limit of £200,000; a total issue of £800,000 thus appears to be contemplated.

Loans are to be made to farmers of an amount not exceeding two-thirds of the estimated value of the security offered, and repayable by equal yearly or half-yearly instalments, including repayment of capital and interest on outstanding debt, over a period not exceeding sixty years. Thus a farmer who has already borrowed money for the purpose of purchasing his farm may replace his existing bond, to the extent of two-thirds of the present estimated value of the farm, by one that will not be disturbed for sixty years (should that be the period fixed), and that will be discharged by fixed annual payments, including interest, and a farmer who wishes to purchase his holding may borrow for this purpose on the same terms.

This part of the Act also provides for loans to be made under the Improvement of Lands Acts for agricultural purposes. Under the present practice, such loans are carried through by the Land Improvement Company, London, on the recommendation of the Department of Agriculture for Scotland. A similar company was formed in Scotland, but it has not operated for some time.

Part II of the Act, which makes provision for agricultural short-term credit, differs widely from the corresponding part of the Act applying to England and Wales. Under the latter a bank is authorised to make a loan to an individual on the security of his assets, such as crops and stock, by means of an "agricultural charge." Under the Scottish Act, loans may be made only to agricultural trading societies on the security of goods belonging to them and in their possession. The "agricultural charge" thus created confers on the bank a security which may be enforced in the same way as a landlord's hypothec, but which ranks after the hypothec of the landlord or superior. The borrowing society is bound, on selling any of the property affected by the charge, to pay the proceeds to the bank. All agricultural charges must be registered with the Assistant Registrar of Friendly Societies within seven days of their execution, and such charges have priority in accordance with the date of registration. It falls to the Court of Session to make rules prescribing the nature of the documents required.

The Local Government (Scotland) Act, 1929.—This is a large and important Act, introducing drastic changes into the system of Scottish local government. These changes are of interest to farmers, as to others, but this is not the place for a full account of them.

The aspect of the Act here dealt with is the "de-rating" scheme embodied in Part II. The injustice of rating agricultural land at its full annual value has long been recognised, and successive reductions have been made by previous Acts. Under the Act of 1926 the owner was rated on three-fourths and the occupier on one-fourth of the gross annual value. The new Act provides that both the owner's and the occupier's rates shall be levied on only one-eighth of the gross annual value of agricultural land and heritages. This proportion represents the assumed value of the farm-house, so that the land and buildings other than the farm-house are entirely free from rates. The proportion originally proposed was one-sixth. The National Farmers' Union of Scotland urged that it should be reduced to one-twelfth; the proportion actually fixed lies midway between these two.

The relief thus given to the landlord is equal to five-sixths of the amount he paid in rates under the Act of 1926, while the tenant's relief is equal to half the smaller amount he paid. In order to ensure that the tenant shall actually enjoy a greater relief than the landlord, it is provided that the tenant shall, during the currency of his existing lease, be entitled to receive annually from the landlord an amount equal to two and a half times the landlord's rate under the new Act, which sum is equal to half the landlord's relief. Where the tenant occupies his farm on tacit relocation, this provision is to be in force not more than seven years from Whitsunday 1928.

An example will make this clearer:—

> If the rent of the farm is £480, and the owner's and occupier's rates each amount to 5*s*. per £, then under the Act of 1926—
>
> The owner pays on £360 at 5*s*. per £, £90.
> The occupier pays on £120 at 5*s*. per £, £30.
>
> Under the new Act—
>
> The owner will pay on £60 at 5*s*. per £, £15.
> The occupier will pay on £60 at 5*s*. per £, £15.
>
> The relief is—
>
> To the owner £75, or five-sixths of his old rate.
> To the occupier £15, or half of his old rate.
> To the owner-occupier £90, or three-fourths of his old rate.
>
> During existing leases the owner to pay to the occupier £37, 10*s*., leaving a net relief in the owner's hands of £37, 10*s*., or five-twelfths of his old rate.
>
> The occupier receives relief of half his old rate (£15) plus

£37, 10*s*. from the owner, making in all £52, 10*s*., or one and three-quarter times his old rate.

As leases expire, the payment of half the owner's relief to the tenant will cease.

It was originally proposed that this part of the Act should come into force at Martinmas 1929, but in its final form the Act provided that it should come into force at Whitsunday. For the year 1929-30 the deduction from both owner's and occupier's rates is 92 per cent. instead of 87½ per cent. (seven-eighths), while the amount recoverable by the tenant from the landlord is four times the landlord's rate, instead of two and a half times.

Artificial Cream Act, 1929.—This Act, which received Royal Assent on 10th May, prohibits the sale or exposure for sale for human consumption of any substance purporting to be cream or artificial cream under a description or designation including the word "cream" unless—

(*a*) the substance is cream as defined in the Act; or

(*b*) where the substance is artificial cream as defined in the Act, the word "cream" is immediately preceded by the word "artificial."

For the purposes of the Act cream is defined as that portion of natural milk rich in milk fat which has been separated by skimming or otherwise, and artificial cream means an article of food resembling cream and containing no ingredient which is not derived from milk, except water or any ingredient or material which under the Food and Drugs (Adulteration) Act, 1928, may lawfully be contained in an article sold as cream.

Receptacles used for the conveyance of artificial cream or containing artificial cream when it is exposed for sale are required to have the words "artificial cream" printed in large and legible type either on the receptacles or on labels attached thereto.

Provision is also made for the registration of premises on which artificial cream is manufactured, sold or exposed for sale for human consumption, and for the inspection of registered premises by an officer of the Food and Drugs Authority. The requirement with regard to registration of premises, however, does not apply where artificial cream is manufactured (1) by a person solely for his domestic purposes; (2) for use in the preparation on those premises of some other article of food; or (3) when it is sold or exposed for sale on premises to which it has been delivered in the properly closed and unopened receptacles.

The Act came into operation on 1st June 1929.

FARMERS' ORGANISATIONS IN THE UNITED STATES.

V. Liversage, B.Sc. (Lond.), M.S. (Wis.), N.D.A.

The experience of other countries is often dismissed with the remark that, having been gained under a specific set of conditions, it is entirely inapplicable where those conditions do not obtain. It is wise, however, not to form a too hasty judgment on the matter. Often conditions which appear dissimilar on the surface have nevertheless fundamental characteristics in common. To the casual observer, for instance, there may seem little in common between the psychological attitude of the American farmer and that of his British counterpart. Fundamentally, observation shows many points in common, and the influences involved in the moulding of the psychological complex may well be environmental rather than national. The attitude of the American farmer towards sectional organisation may be considered from this point of view.

In the earlier days of American agriculture—and here consideration is directed particularly towards the United States—the system followed was mainly a self-sufficing one. If we except the case of the cotton and tobacco growers, the rise of the modern system dates from about the middle of the last century, when it received a tremendous impetus from invention of newer types of farm implements and the opening up of huge fertile regions in the Middle West. The introduction of the modern system with its wide separation of producer and consumer gave rise to many of the problems which confront agriculture even to-day, and for the attacking of these problems history records the appearance and decline of a series of organisations passing in almost kaleidoscopic succession.

Farmers' organisations may be divided into three broad classes, and although the functions of each overlap to some extent the main emphasis differs widely in each case. In the first place there are bodies of the kind typified in Britain by the Royal Agricultural and the Highland and Agricultural Societies, which are concerned with the spread of education and development in mainly technical directions. This type maintains a position somewhat aloof from the actual business of farming.

Very different is the "Union" type, which is a class-conscious association of farmers for all or any purposes connected with their material or social welfare. It covers a wide field of activity from the spread of technical education to the furtherance of political objects. Its constitution is of a democratic character and it acts as the mouthpiece of the agricultural industry in general. Its services are mainly of an auxiliary character, but in England it has made a direct entry into business matters by carrying out collective bargaining for its members. The fundamental difference between this type and the preceding is the commercial and class-conscious basis of the Union.

The third kind is the co-operative society in the narrow sense of the term, an association of individuals for a definite business purpose, whether the selling of farm produce, the purchase of supplies, or other purposes. The scope of work is much narrower than in the case of the Union. Though services of a general nature are performed, such as social work, these are merely incidental to the main purpose of the association. The co-operative society is not a class organisation but a form of business partnership.

The Union and the co-operative society are not always distinct in practice. Co-operative business action may be undertaken by an organisation of the general type. The insurance scheme and the collective bargaining of the National Farmers' Union in England is a case in point, and the question sometimes emerges of the extension of work in this direction. In America this kind of combination of direct and auxiliary services has been attempted, and its feasibility forms one of the problems with which the present account is concerned.

In the United States previous to the middle of the last century such organisations as existed were of the educational type. The emphasis was upon matters of crop and stock improvement and better methods of husbandry. Soon after the middle of the century a new tendency began to assert itself, and farmers' organisations began to enter directly into the field of business activity. Attention was shifted from technical to economic matters. The period was especially conducive to such a development. The main wheat-growing area had shifted from the eastern part of the country out to the Middle West, and rail transport had become an important factor intervening between the centre of production and the terminal market in the east of the country or in Europe. Rail rates were high, and various abuses such as freight rate discrimination were practised by the railway companies. Periods of high prices for wheat during the Crimean War of 1854-5 and the American Civil War of 1860 were succeeded by periods of abnormally low prices. Production had expanded to such an extent during the high-price periods that there was a surplus and a slump in prices following. While prices for farm products were low those of manufactured products, particularly farm machinery, were high, and farmers began to agitate for certain reforms promising amelioration of their condition. New organisations began to develop.

The first of these to assume national importance was one called the Grange, a body which owed its inception to the activities of a government employee named Kelley. Under his influence the first Grange was established at Washington in 1867. The organisation was built on the lines of a secret society with an elaborate ritual. At first the desired improvement in economic conditions was attempted through the gradual and peaceful means of social intercourse and education, but such a mild policy was soon abandoned for a bolder one of plunging directly into co-operative schemes and into politics. The main

efforts were directed towards the elimination of some of the middlemen's margin and the securing of more favourable freight rates. Its political activity was characterised by immoderate vituperation against distributors, railway companies, bankers and "big business" generally, and an attempt was made to supersede the existing system by the wholesale establishment of co-operative marketing and requisite societies. Even the milling of flour and the manufacture of farm machinery were undertaken. These schemes were launched in a precipitate manner and contributed largely to the subsequent decline of the Grange, failure bringing the whole organisation into disrepute with farmers.

Within a few years the Grange had spread over the country like a conflagration, and with little construction had exhausted its resources and remained a mere smouldering remnant by comparison. Profiting by its misfortunes it later abandoned its militant policy, received steadier support, and now occupies a position of some importance in the country.

The Grange was followed by a succession of other bodies with similar objects but differing in the methods of their attainment. The Grange endeavoured to avoid partisan politics. The next organisation to occupy the centre of the stage, the Alliance, was by contrast frankly a political body. While the Grange had depended on direct action, the Alliance pinned its faith on Government help. The latter organisation grew out of a small association in the south for the purpose of mutual protection against the depredations of horse and cattle thieves. This incipient stage was swallowed up in a wide political movement in which an attempt was made to secure a voice in the national affairs by the formation of a farmers' political party. Unlike the Grange, it made no efforts in the direction of social intercourse and technical education. The chief objects were the elimination of speculation from the grain and cotton trade, nationalisation of railways and other means of transport and communication, the free coinage of silver, and the transference of taxation from real estate to incomes. It is interesting to note the recognition that one of the root causes of agricultural distress in the 'eighties was the contraction of the currency caused by reduced gold production and withdrawal of the "greenback" note issue in America. The attempt to form an independent political party met with decisive failure in the elections of 1892 and the organisation came to a speedy end.

The Farmers' Union and the Equity, both of which arose about the beginning of the present century, profiting by the fate of the Alliance, avoided direct political activity and endeavoured to improve the lot of their members by schemes of marketing and supply. As in the previous movements the dominant note was the conflict between agricultural and business interests and the malign operations of the middleman. A new line of attack was now tried. An attempt was made to raise the prices of agricultural produce by mutual agreement and by restriction of

output. It was the belief of the Union that the marketing of cotton, the most considerable product with which it was concerned, was in the hands of bodies mainly concerned with gambling and with manipulation of the market. To correct this evil the course was adopted of fixing a price for the raw cotton. The price was to be insisted on by every farmer growing cotton, in which case the situation would be entirely in their hands. Accordingly, in 1904 a minimum of 10 cents per pound was agreed upon for "middling" cotton. The ruling price nevertheless remained below 9 cents. A price of 11 cents per pound was put on the 1906 crop. The price commenced at 9·25 cents but gradually rose until it reached 13 cents. The Union claimed a large share of the credit for the rise in price, and it is probable that it influenced farm receipts by inducing many farmers to hold their produce off the market during the slump period following harvest. But in view of the yield for the season the price was about what might have been expected. Taking courage from apparent success the Union next year fixed a price of 15 cents. Almost all, however, had to be disposed of at from 10 to 12 cents. In 1908 the attempt was continued, but with a yield somewhere near the maximum the situation got beyond control and had to be left to the free play of market forces.

It was observed that a small crop of cotton was sometimes worth actually more in the aggregate than a large one, and the plan of artificially restricting the supply was hit upon. Energetic canvassing of growers and "night rider" methods resulted in a decrease of acreage in 1905 from 30,000 to 26,000. The price advanced by 25 per cent. and success appeared certain. This very success, however, proved its undoing. With a higher price in prospect, obviously those would benefit most who had most cotton to sell, and the resulting situation was pictured by a leader of the Union in the statement, "Whenever we tell the farmers to plant less cotton they plant more."

Painful experience was also gained by a section of members of the Equity who were engaged in the production of a kind of tobacco known as Burley tobacco, the culture of which was confined to a small area in Kentucky. The growers, dissatisfied with the price received from the manufacturers, decided to hold up supplies against an agreed minimum price. The increase of price, however, stimulated further production, with the subsequent discovery that this kind of tobacco, which before was confined to hill regions, could be grown more advantageously in "Bluegrass" regions where it had never before been attempted. The resulting situation disorganised the whole scheme of control, and instead of the alleviation which was hoped for, the position of the manufacturers was made far stronger than before.

Such experience is by no means without parallel elsewhere, and illustrates the dangers involved in attempting any interference with the course of economic forces. At the same time these activities were not entirely unproductive of useful results. One useful feature which resulted was a scheme for providing

credit in connection with warehouses, using the produce deposited as "collateral." This resulted in withholding in early autumn a large amount of produce which otherwise would have had to be dumped on the market in order to provide cash for immediate needs.

These and similar experiences have helped to bring about a change towards a more constructive tenour of the conduct of farm organisations. Though the Equity is now of a merely local character, the Farmers' Union has retained its influence and support and still conducts some successful co-operative ventures, chiefly in Nebraska and neighbouring States.

A recrudescence of political activity was seen with the rise during the later years of the Great War of the Non-Partisan League. The objects of this body were similar to those of the Alliance. The plan followed, however, was not to form a separate political party, but to support members of the established parties who were pledged to further the sectional aims of the farmers. The chief objects were the nationalisation of terminal grain elevators, flour milling, meat packing and cold storage plants—in other words, the elimination by legislation of most of the existing private agencies buying agricultural produce on a large scale—Government grading of grain and improved credit facilities. This movement has received rather limited support, and has been overshadowed by the rise of the latest and in many respects the greatest of this succession of farmer movements—the Farm Bureau.

The Farm Bureau first arose about 1914 in the State of New York. It was closely connected with the provision of county organisers or "agents" under the Smith-Lever Act. In its early stages it was essentially an educational body concerned with production problems and supported partly by public funds. As control has passed into the hands of farmers the character of the organisation has undergone a complete metamorphosis into a commercial and class-conscious body similar in general type to those previously described. Like them it is organised on a democratic basis, policies being directed by members through the local group, the county branch, the State, and finally the national organisation. Growth has been from the bottom upwards, with the local group as a starting point. This is in sharp contrast to the Grange, the Farmers' Union and the Equity, in which officers, sometimes self-appointed, have shouldered the task of creating an organisation to support the central body. Its purposes are of a general nature, and it has established separate departments dealing with matters such as politics, publicity, transportation, marketing, co-operation, law, and so forth, in a manner similar to that followed by the Farmers' Unions in Britain. It avoids party politics, though a representative holds a watching brief at Washington. Its main activities are of an economic character, and it has been very enthusiastic in promoting the formation of independently controlled co-operative marketing associations.

Some of the American farm organisations of the Union type have had only an ephemeral existence, while others have passed through critical stages. Those now existing are able to draw upon a fund of experience which enables them to avoid many of the pitfalls which have contributed to the downfall of their precursors, and which beset any work of a like nature. In spite of the sympathetic attitude of the American mind towards collective action and team work the path of agricultural organisation has been a thorny one. We in this country tend to regard individualism and conservatism as attributes peculiarly applicable to the sturdy British yeoman, and yet they are just as formidable obstacles to group action on the family farms of the North American prairies as among the capitalist farmers of our own country. Comparative isolation breeds a degree of caution towards things outside daily experience which amounts almost to distrust and suspicion. It manifests itself in the difficulty with which farmers can be induced to join an organisation or a co-operative scheme, and the frequent allegation by them that the leaders have some private end to serve. It accounts also for the occasional defection of members from mutual agreements for the sake of private but temporary gain. Members can often be bought off from a co-operative venture by the offer of a temporary advantage which would be estimated at its true value if a broader view were taken. The difficulty has been augmented by some leaders who have raised extravagant hopes the non-fulfilment of which has given rise to disillusion and scepticism. It is one which has affected particularly those which, like the Grange, the Equity and the Farmers' Union, were developed from the top downwards rather than in the opposite direction. The realisation has been forced home that individual loyalty is not a dependable basis on which to build a business structure; the binding contract is an indispensable condition to security.

Closely associated is the lack of homogeneity in the farming community. The industry is a composite one, consisting of a variety of productive enterprises carried on under a variety of conditions. Sectional interests often clash; the advantage of one section is often the detriment of another, and what vitally concerns one section is often a matter of indifference to another. One of the main points in the policy of the Grange was in regard to the rail rates on wheat from the Middle West to the coast. The eastern farmers were close to their final market or terminal port, and the heated tirade against the railway companies left them cold. Cotton, maize and tobacco growers wanted credit to enable them to tide over the glut period immediately following harvest; dairy farmers had a more regular distribution of income over the year and were not particularly interested in the provision of short-term credit. The feeder of cattle and pigs wanted cheap grain; the grain grower wanted a good price for his product. These divergencies of view are of course mitigated by the fact that few farmers have but one interest, and the more diversified the system of farming the less

noticeable do they become. Nevertheless they are very real factors in the situation.

The chief objects before farmers' organisations have been of a pecuniary nature, and yet pecuniary considerations have sometimes proved something of a stumbling block. More weight is commonly attached to the comparatively small amount paid out in the present than to the much larger amount which might possibly be received in the future. Even where the subscription has been trifling there has sometimes been a considerable falling-off in paid-up membership in times of depression until a measure of desperation caused a swing of the pendulum in the opposite direction. It is the opinion of many that in order to be of any great service an organisation must be well supported financially. If the membership fees are high members have an excuse for expecting benefits in proportion, but often great returns are expected from an insignificant subscription. One official advanced the humorous but poignant suggestion that a high subscription maintained interest through the anxiety of the members concerning the fate of it.

In the earlier movements co-operative business activity was undertaken by the general body, the direction of individual enterprises being delegated to special committees elected from among the general body of members. The necessary managerial experience in many cases was not forthcoming, or at least was not obtained, and the failure of particular schemes involved the whole body. It was so in the case of the Grange, and was true also of the Alliance and of the Farmers' Union. The course of evolution has tended unmistakably towards the adoption of the single commodity as the basal unit for the conduct of business activities, and the fostering of societies independently controlled. This tends to mitigate the effect on the parent body of failures in particular directions, though the former is unlikely to escape repercussion entirely. There is a looseness of structure in a group organisation which gives rise to serious difficulties if it engages directly in business. There is a lack of permanent ties, as a member has only to withdraw if dissatisfied. He does not need to forfeit more than his membership fees, and in many cases can avail himself of the benefits which the organisation has been able to secure while remaining outside it. There is a somewhat indefinite gradation of importance within the organisation itself, giving opportunity for petty jealousies to develop. In case of disagreement the whole body becomes split into factions. In private business concerns it is usually possible to mete out some form of punishment to defaulting members or even to entirely independent persons whose activities may have any relation to the concern in question. In these respects the co-operative society does not offer a complete solution of the difficulties, but the greater reliance on salaried officials rather than on committees and honorary officers does a great deal towards mitigation of the evils

A sentiment appears to be growing that even within a general

organisation the commodity structure might with advantage become more prominent. Instead of automatically becoming concerned in every part of the work of the organisation a member might join the general body as a preliminary, and then enter the particular commodity group or groups in which his interests chiefly lie. Thus he would first become a member of the association as a whole and become concerned in its general activities. If a milk producer he would then join the milk section, if a cheese-maker the cheese section, if a wheat grower the wheat group, and so on, but he would acquire no concern in sections other than those of which he specifically became a member. This arrangement would result in a concentration of voting power in the hands of members directly concerned in a particular matter and of focussing their attention on the subjects in which they were most interested. It would avoid the situation appearing in, for example, the Farmers' Union in Britain, in which a sectional committee for milk questions is elected in part by barley growers and beef producers, and in which potato growers might have to enlist the support of a body consisting mainly of milk producers. The commodity grouping assists in fostering the idea of business partnership as distinct from semi-altruistic association. Measures may be taken or special funds collected and utilised by a sectional branch towards objects which would receive at best the much divided attention of the general body of members.

It has been remarked that the power of a farmers' organisation is in proportion to the virility of its local branches, and some form of political activity is almost necessary to sustain interest among the members. When certain objects have been attained or an attempt has proved a decisive failure there is a tendency for interest to die down, and if this is allowed to go on the end of the organisation soon follows. It becomes a mere empty structure, a set of officers without any following. Nothing stimulates the activity of local branches more than a lively interest in current political matters affecting the agricultural industry. But this activity generally needs guidance along sound lines. Farmers have in the past shown a singular facility for concluding that their ills are the result of unjust legislation and that legislation is the logical method of curing them. The history of the organisations discussed shows them agitating for Government action now against the corn exchange speculators, now against the railways, meat packers, machinery manufacturers; now pressing for expansion of the currency by the issue of fiat money or the free coinage of silver. One of the most frequently recurring cries has been for a form of government subsidy or for higher tariffs. To-day the cry is for government ownership of fertiliser plants and for a nation-wide scheme for disposal of surplus produce abroad. Thus appears the anomalous situation that in the face of problems of supposed overproduction the energies of farmers are being directed towards increasing the surplus. Some of the objects pursued have been commendable; on the other hand much energy has been wasted in the

prosecution of shortsighted or even absurd policies. It is said that a group consisting mainly of owner-occupiers allowed itself to become officially committed to the support of the single tax! A vague kind of railing against "big business" has become perennial. It is here that the assistance of the scientific economist as distinct from the mere politician, or that species of reformer whose utterances are of the "hot air" variety, is of the greatest value. In more than one case disaster has followed the dissensions introduced by an entry into partisan politics.

One of the most persistent political and economic delusions is that the middleman can be eliminated. Co-operation is to many a magic word the utterance of which has power to narrow the great gap between producers' and consumers' prices. A highly complicated and specialised system of distribution has been developed through the years, and the only justification for substituting a new system must be the fact that it is more efficient than the old. Too often a marketing venture has been entered into merely because it was co-operative; the matter of efficiency was somehow overlooked. The necessity for getting experienced men for executive positions and paying a salary as high as other large interests can afford to pay has not always been appreciated. Farmers themselves have not the opportunity of gaining experience in business management, and in fact they often fail to make a wise choice from among persons supposedly qualified for a particular appointment. Hence many schemes have failed largely from want of efficient managers. It is true that the earlier efforts suffered from the extremely rapid rise in influence which they achieved. Their leaders were not prepared for the magnitude of their task. Extravagant hopes gave rise to revolutionary schemes promising immediate and complete relief, and their very radical nature proved their downfall. These experiences have brought about a change towards a more moderate and constructive attitude. Thus O. M. Kile, a leader of the Farm Bureau, says that it ". . . hopes merely to apply to the various phases of agriculture as an industry the ordinary principles of good business and good government, and asks only that existing restrictions be removed so that free opportunity is given for the realisation of these aims. The farmer has no desire to perform merchandising, manufacturing and other services now performed efficiently by existing agencies. . . . His ideal is the greatest service at least possible cost consistent with legitimate returns for effort and capital actually expended."

Time has demonstrated the futility and danger of attempting in any drastic manner to interfere with the operation of the laws governing supply, demand and prices. Within the limits set by these laws, however, much useful work has been accomplished. Though one organisation after another has arisen only to sink into comparative obscurity or to disappear entirely, yet time and again another has arisen in its place, and to-day their combined forces far surpass former periods in numbers, influence and in the volume of business transacted annually by societies sponsored by them.

INSECT PESTS.—No. V.

R. STEWART MACDOUGALL, M.A., D.Sc.

BUTTERFLIES AND MOTHS.

BUTTERFLIES and Moths belong to the order *Lepidoptera* or Scale-winged insects (*lepis* = a scale, *ptera* = wings). The scales are modified hairs, and not only cover both upper and lower surface of the wing, giving rise to numerous and varied colour patterns, but also cover the body. Everyone who by chance handles a moth observes a powdery material coming off on the fingers, and this powder under the microscope reveals itself as flattened scales, varying considerably in shape even from the same wing. Typically a scale is a flattened sac with a pointed end that fits into a pit or pocket in the skin and so is held in place, and an expanded part fringed or toothed or entire at the apex. The scale may hold only air, but pigment is sometimes present. The scales are in rows, and there is a lateral overlapping as well as an overlapping of the base of each scale by the upper part of the scale behind. All the colours and colour pattern of the gay butterfly or the moth are due to the scales, the colours being due to pigment or due to physical reasons—a play of light on the very fine lines that run down the scale—or due to a combination of the chemical and the physical. The wings are four in number, the two front ones larger than the hind ones. When the scales are brushed or rubbed off, the wing is seen to have a number of supporting veins, and the number and arrangement of the veins are used to distinguish one species of butterfly or moth from another.

The head carries two large compound eyes, a pair of jointed antennæ and the mouth-parts. The antennæ are sensory structures functioning as organs of smell and organs of touch. Adult butterflies and moths take liquid food. The mandibles or jaws, well developed in other insects that make use of solid food, are here quite reduced. A portion of each first maxilla is modified to form an elongated half-tube; the two halves are linked together to form a sucking tube up which is drawn nectar from flowers, or exuding sap, or the juices from over-ripe and decaying fruit. When not in use this proboscis is carried coiled up like a watch-spring. Some *Lepidoptera* do not feed at all as adults, while again in some the mouth-parts are better developed than usual.

The head is followed by the thorax, which carries six legs and the four wings mentioned. In some butterflies all the six legs may not be functional, and we shall find later that there are some moths where the females have only rudimentary wings or no wings at all. The abdomen follows the thorax and is without external appendages, although dissection may reveal claspers of service in pairing.

In the life-cycle of butterflies and moths there is a complete metamorphosis with the four stages of imago or adult, egg, larva or caterpillar, pupa or resting stage. The adult has for its main function the provision for the future of the race—mating

and laying eggs. The length of the adult life is very variable, depending on the species, on the weather, and on how soon a favourable place is found for the laying of the eggs. Several of our butterflies hibernate in the adult butterfly state, e.g. the Tortoise Shell Butterfly, the Camberwell Beauty (*Vanessa antiopa*), recorded not only from the south but from places all over the north and west of Scotland, the Peacock (*Vanessa io*), the Red Admiral (*Pyrameis atalanta*), and the Brimstone (*Gonepteryx rhamni*). These are very attractive when they show themselves in the open, having been tempted out of their shelter places by a bright winter's sun. Such butterflies may live from seven to nine months as adult; the pairing does not take place until after the winter, although these butterflies may have had an active outdoor life for a month or more in the previous autumn.

Butterflies are not sound winter sleepers; they respond easily with renewed activity to a higher temperature and a bright sun. The climate of Britain is not favourable for butterflies all the year. There is not enough sunshine and warmth to keep the insects in flight all the year round, while the winter's cold is not lasting enough to keep the hibernating species dormant all winter. Changes in temperature are frequent, sunny days being followed by a cold snap, so that the sleeping butterflies, wakened prematurely and tempted out by the sun, run a great risk.

The eggs hatch in varying lengths of time. Some hatch in a few days, or a week or two, whereas the eggs of some species which are laid in autumn or late summer may remain as eggs over the winter, not hatching until the next spring or early summer.

The larva is a caterpillar made up of head and 13 following joints (often only 12 can be easily counted). The head is hard and horny and often carries simple eyes on each side, a pair of minute antennæ, and the mouth-parts, of which the mandibles are generally prominent. The caterpillar takes solid food, its gnawing power being attested by destruction of bud and leaf and fruit. The caterpillar has 16 legs, a pair on joints 1, 2, 3, 6, 7, 8, 9, 13. The first three pairs of legs are known as the thoracic legs; they are hard and jointed and end in a claw. The other legs are soft, fleshy, unjointed, and are spoken of as prolegs, or proplegs or abdominal legs; the sole of the foot is either grooved in the longitudinal direction, with hooks along the edges, or is undivided and circular. The first kind of foot is characteristic of caterpillars that live freely on the food plants and are mobile; the unhooked sole is found in caterpillars that live in the inner parts of plants or in wood.

In one moth family, the *Geometridæ*, the caterpillar has only ten legs, viz. the three pairs of thoracic legs and a pair on joints 9 and 13. These caterpillars progress by a looping or spanning movement and are known as loopers, or spanners, or measurers or geometers (measurers of the earth). Often these geometer caterpillars, gripping a twig or branch by their hind claspers

and standing out from the twig, supported by a silken thread, look like twigs, their colour also helping in the deception. More than once I have seen people surprised to find a soft squirming caterpillar between finger and thumb when they had attempted to lift a branch by what seemed an ordinary twig. This camouflage has protective purposes.

Apart from the *Geometridæ* we shall find that some other caterpillars to be mentioned have a less number of legs. Rarely legs may number 18, and also rarely legs may be entirely absent. Speaking broadly, any larva with biting jaws and 16 legs or 10 legs must be the caterpillar of a butterfly or a moth.

Along each side of the caterpillar dot-like spiracles may be seen, the openings by which oxygen enters and carbon-dioxide leaves the tracheæ or breathing tubes. The spiracles are found one on each side of joints 1, 4, 5, 6, 7, 8, 9, 10, 11.

Caterpillars vary greatly in external appearance; they may be bald or hairy; the hairs may be simple and uniformly spread or they may be arranged in tufts or tussocks; the hairs may be harmless to people who handle them or they may be irritatingly painful; the caterpillar may be smooth or covered with warts; colour also varies through all shades from dull to gay; the caterpillar may so harmonise with its surroundings as to be "protectively coloured," that is it may be overlooked by insect-eating enemies; or the caterpillar may challenge attention, e.g. by bright yellows and black, such "warning coloration," characteristic of some nauseous-tasting or offensive caterpillars, helping to advertise the caterpillar to bird or lizard and so acting as an insurance against attack.

The caterpillar as it feeds increases in size, but the outside covering of the caterpillar disfavours growth, and, to prevent growth being cramped, periodical moults take place, four or five or it may be more; the intervals between the moults are known as instars or stages, and the caterpillar may show colour differences in different instars. This moulting or ecdysis is not confined to the external covering with such hairs and spines as may be present, but extends to the horny lining of breathing tubes and the horny lining of the front and hind regions of the alimentary canal.

The length of the caterpillar life is very variable, according to species and environment; in the case of species which hibernate as caterpillars the larval stage is naturally lengthened out. The important thing to grasp is that the larval or caterpillar condition is the time of feeding; the business of the caterpillar is to eat and to eat more, and to eat still more until it is full-fed. This feeding is accompanied not only by an increase in size but also by a storage of reserve known as fatty body. This reserve is made use of during the quiescent non-feeding pupal stage when the future adult is being perfected; and also in the adult stage of such butterflies or moths as do not feed and yet require reserve to mature their reproductive organs, and—in the case of the females—to furnish the eggs with yolk.

The full-fed larva in some shelter place, either on the food plant or away from it, passes into the pupal or resting condition. The caterpillar moults for the last time and the pupa is revealed with, for example, in the chrysalid or pupa of the Large Cabbage White Butterfly, recognisable wings or wing sheaths, eyes, proboscis, antennæ, spiracles. The fact is that throughout the whole life of the caterpillar development and changes are taking place, but the changes are so important and so deep that they cannot be properly completed while the larva moves about, and therefore a pupal or resting or lying-up stage is necessary. The reader will at once appreciate the need for such a resting stage when he recalls how different in habit and environment the creeping, crawling, many-legged caterpillar is as compared with the graceful, active, flying, nectar-sipping adult.

The details of the changes that take place before and during pupation are extremely interesting but are outwith the purpose of this article.

During the period of rest the pupa needs protection against enemies and against such weather influences as drought and wet; the pupa must not dry up nor must it become mouldy. We expect then to find the pupa sheltered under leaves, or in crevices in bark or badly pointed walls, or under litter or in the soil. Sometimes the pupa is naked, and this is characteristic of butterflies, but with most moths a protective cocoon surrounds the pupa. The caterpillar first constructs the cocoon and then moults for the last time; one finds on opening a cocoon not only the pupa but the withered looking shed skin and the jaws of the old caterpillar.

As with the other stages in the life-history of moth and butterfly, the length of the pupal stage is very variable. With many *Lepidoptera* the winter is passed in the pupal stage, hence a great part of a year's life of butterfly or moth may be as pupa. The length of pupal life varies in the same species with the conditions, thus the summer brood of Large Cabbage Whites may have a pupal stage of a fortnight, while the pupæ of the autumn brood do not give out their adults until the next early summer.

It is characteristic of Lepidopterous pupæ that the wing sheaths, the legs, the proboscis, the antennæ are all firmly fixed down, glued by the drying and hardening of a fluid secreted by the outermost layer of cells. This hard shell or cover or sheath is well seen in the chrysalis or pupa of the Cabbage White Butterfly; it is through a split in this shell that the adult emerges when ready.

One does not perhaps associate powers of enduring flight with these "frail children of the air," but migration is not uncommon with some butterflies and moths, and in the course of it considerable distances may be covered. For some the North Sea and the Channel present no difficulty. One butterfly migrates from Palestine to Iceland. Periodically the Clouded Yellow (*Colias edusa*), whose caterpillars feed on leguminous

plants, crosses the Channel in immense numbers and spreads all over the country right to the Orkneys. Eggs are laid and a new brood of butterflies is reared, but the species is practically killed out later in the year by cold and damp. Some of our native species both of butterfly and moth are added to by the access of immigrants. Some immigrants push still further north. As distinct from bird migration, there is no return flight. A complete reason for insect migration cannot be offered, but overcrowding is often a contributing factor.

Classification of Lepidoptera.—A convenient but not strictly scientific division is into the butterflies and moths.

Butterflies.	*Moths.*
The antennæ are drumstick-like ending in knobs.	Antennæ not knobbed.
Rest with their wings held erect and back to back. The exposed under side of the wings has no attractive colour pattern; in some cases there are bright patches on the under side of the front wings, but they are hidden by the front wings being slipped back behind the other pair.	Rest with the wings sloping like the roof of a house. Some moths have brightly coloured hind wings, but at rest these are covered by the dingy front wings.
Fore and hind wings not linked together by a bristle when in flight.	Fore and hind wings often linked together in flight by a bristle at the base of the hind wing which fits into stiff hairs on the under surface of the front wings.
Fly by day.	Fly at dusk and by night.

There are exceptions to these distinctions, e.g. the Red Admiral and the Painted Lady among butterflies may be found in flight in the gloaming, while some moths fly by day and hold their wings erect and back to back when resting. In spite of exceptions the differences given are good general differences; the difference in antennæ is particularly helpful.

BUTTERFLIES.

Adult butterflies feed on nectar. Some are greedy for the honeydew voided by aphides, and some take with zest sap exuding from unhealthy trees.

Butterfly caterpillars are almost exclusively vegetarian. The larvæ of some of the Blues (*Lycænidæ*), however, are cannibals at certain stages of their life. Some species live on friendly terms with ants, which, in exchange for a sweet secretion from a gland on the caterpillar, give protection against parasitic and predaceous enemies. A particularly interesting case is that of the caterpillar of the Large Blue (*Nomiades arion*), a rare species now in England. The female lays her eggs on the flowers of wild thyme; the larvæ on hatching feed on the thyme, though in some stages they show marked cannibalism. In their last instar they feed on the young larvæ of ants. The caterpillar in this stage puts itself in the way of an ant. The Large Blue caterpillar responds to the caresses and touch of the ant by giving out a bead of sweet

liquid from a gland on the upper surface of the tenth segment. Then the Large Blue larva hunches up its thoracic joints into what resembles a swelling, on which signal the ant strides over the caterpillar, seizes it just behind the swelling, and with much labour carries it to the underground ant nest, "deep down into the pitch darkness of the centre of the nest—a sombre contrast to its previous abode amid blossoming thyme in glowing sunlight." [1] The Large Blue caterpillar now feeds on ant larvæ, hibernates in the ants' nest, pupates in the ants' nest, and the adult butterfly issues from the nest into the open.

The Small Tortoiseshell (*Vanessa urticæ*) (Fig. 1).—This butterfly, common all over the country from the south of England to the Orkneys, may be taken as an example of an insect easy to observe and one that does not shun the abodes of men. The ground colour is reddish-orange with yellow patches, and white, black and blue spots. Along the edge of the front wing there are

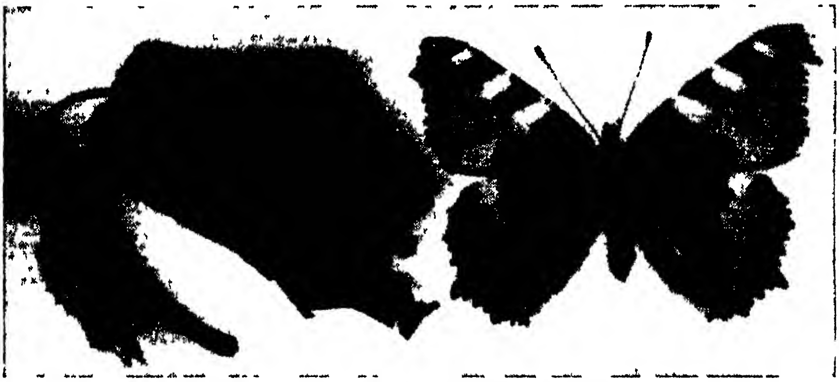


FIG. 1.—The Small Tortoiseshell Butterfly.
On the leaf the caterpillar is seen, and hanging from the leaf stalk on the left the pupa.

somewhat square-shaped black spots separated by yellow areas; there are two small dark spots in the middle of the wing and a larger dark spot near the centre of the hind margin; down the outer edge of the first wing there is a series of blue crescents or spots. The hind wings are dark at the base, reddish orange in the centre, and there is along the outer edge blue markings like those on the fore wing. The long antennæ are dark, tipped with yellow. The insect then is very conspicuous from the upper surface but the undersides of the wings are so sombre in colour that when the butterfly is resting with wings erect it attracts little or no attention; there is a light patch in the centre of the underside of the front wings, but in a state of rest this is hidden under cover of the erected hind wing. The Tortoiseshell butterflies come from their winter quarters and are found laying their eggs in May and June. The female resting on the upper surface of a leaf of the stinging nettle curves round her abdomen and lays

[1] *Natural History of British Butterflies*, by F. W. Frohawk, vol. ii (Hutchinson & Co.).

a heap of eggs on the undersurface of the leaf. The eggs, green at first, turn yellowish later. The eggs hatch in ten days and over, according to the conditions. The caterpillars are gregarious, feeding together, chiefly on the end leaves. If the caterpillars be very numerous they separate up into smaller groups. It is interesting that the caterpillars of three such beautiful butterflies as the Tortoiseshell, the Peacock and the Red Admiral all feed on nettle. The caterpillar is full grown in a month in favourable conditions, and has moulted four times. In its last stage the caterpillars separate and feed singly, sometimes under the shelter of a leaf caught by silk at the edges.

The caterpillar in its last stage varies in colour, some being dark brown on the upper side, others paler; a black line edged with yellow runs down the middle of the back; rows of tubercles ending in spines run down the back; the spiracles are dark, edged with yellow; the six thoracic legs are dark, the ten prolegs greenish.

The full-fed larva may pupate on the underside of a leaf of the food-plant or may wander away to pupate under cover of some ledge or paling. The method of pupation is interesting. The caterpillar spins a pad of silk attached to the support. The caterpillar then moults and the pupa is revealed; the pointed hind end of the pupa, known as the cremaster,[1] has hooks on it; the hooks grip into the pad of silk, the moulted larval skin falls away, and the pupa hangs suspended. By a fortnight the new butterflies are in flight. Pairing and egg-laying follow, and in August and September the autumn butterflies issue, i.e. there are two broods in a year.

The August and September butterflies remain in the open for a time and then hibernate as adults. It is common for the Small Tortoiseshell to come into houses and churches for winter shelter. I have found the butterfly passing the winter in a bedroom and in a boxroom; in another bedroom the putting on of fires woke up a hibernating butterfly from its winter sleep. The Rev. O. Pickard Cambridge has recorded how a Small Tortoiseshell butterfly flew into his church one Sunday in August, "settled down on a rafter in a position visible from the pulpit, and remained motionless till May 5 in the following year."

The family to which *Vanessa urticæ* belongs is the *Nymphalidæ* or Brush-footed butterflies; the front pair of legs in both sexes is dwarfed and useless for walking; the short tibiæ are covered with long hairs.

The Cabbage White Butterflies.—Of the 68 British butterflies the only ones which in Britain can be said to be troublesome to the farmer belong to the family *Pieridæ* containing the Whites, the Brimstone and the Clouded Yellows. Of the Whites that call for notice are the Large Cabbage White (*Pieris brassicæ*), the Small Cabbage White (*Pieris rapæ*), and the Green Veined Cabbage White (*Pieris napi*).

The Large Cabbage White Butterfly.—Everybody knows

[1] Cremaster is a Greek word meaning suspender.

this butterfly (Fig. 2). The front wings of the male are black at the tip, those of the female have in addition two black spots and on the hind margin is a black dash.

The first butterflies of the year are seen at the end of April and in May, having come from pupæ which have overwintered. After pairing the female lays her eggs in clusters of from 40 upwards; the eggs, laid on both upper and lower surface, are yellow in colour, stand up on end, and have longitudinal ridges with concave interspaces. The larvæ hatch in ten days to a fortnight and make a first meal of their egg shells. In the early part of their lives the caterpillars are gregarious. Some threads are spun to give a footing on the smooth leaf-surface. Later on the larvæ spread over the plant. The caterpillar moults four times in the course of its life, and in favourable conditions larval life may be completed in a month.

The caterpillars are bluish-green or yellowish-green, dotted all over with black warts that bear hairs; there is a yellow stripe

FIG. 2.—The Large Cabbage White Butterfly (Female).
On the left a moribund caterpillar almost covered by the cocoons of the parasite *Apanteles glomeratus.*

down the middle of the back and yellow side stripes; the spiracles, which are not conspicuous, are pale grey with dark border; the legs number sixteen.

The full grown caterpillar may in the summer brood pupate on the food plant, or may leave the plant to pupate in some shelter place under the eaves of a house to which they climb or under the coping of a wall or a paling, in an outhouse, or on a neighbouring tree trunk. The pupæ or chrysalids may be horizontal in position, but a common position is erect with the cremaster end fixed by hooks to a little pad of spun silk, the body being further supported by a girdle of silk. The chrysalid is whitish or yellowish green (there are colour differences according to the environment) with black points and spots; all down the back is a keel, which rises to a sharp point in the middle of the thorax; the bent head, the knob-like projections of the compound eyes, the proboscis in the middle line, the outline of the wings, portions of two legs on each side of the proboscis (the third pair of legs are hidden

under the wings), the two antennæ ending in knobs, are all visible on careful examination. Pupation lasts a fortnight, and the adults that come away pair and lay eggs, the caterpillars from these becoming full grown and pupating in autumn. Normally these autumn pupæ hibernate, the butterflies coming away as stated at the end of April and in May. Normally there are two generations in a year, but in very favouring conditions in the south there may be a third or a partial third generation.

The food plants of the caterpillars are typically cruciferous plants—cabbage, cauliflower, brussels sprouts, kale, turnip, rape, white mustard, hedge mustard, jack-by-the-hedge; but some plants of other orders are willingly eaten, e.g. tropæolum and mignonette.

In some seasons swarms of the Large Cabbage White come over the sea to land and spread over Britain. Ships sometimes reach our ports covered with the butterflies.

The Small Cabbage White.—This species is also migratory, great numbers flying oversea to our shores. The food plants and life-history of the caterpillar resemble those of the Large Cabbage White, but one should notice that the eggs are laid singly, on the under sides of the leaves, and the larvæ are solitary in habit. Each egg shows twelve longitudinal ridges. The Small Cabbage White appears a little earlier than the Large Cabbage White. It resembles greatly the last species, but normal specimens have a less spread of wing; the hind wings on their underside are dotted over with dark points. The caterpillar is pale green dotted all over with dark points, from each of which a pale hair springs; a narrow yellow line runs down the back and there are narrow yellow side stripes; the caterpillar has a velvety appearance. The pupa is pale flesh-brown dotted with black; the antennæ and the legs and the head are rather darker than the general ground colour.

The Small White introduced into the United States some years ago has multiplied and spread there and into Canada; indeed in North America it seems to be replacing native species.

The Green Veined White Butterfly.—This butterfly is a little smaller than the last, from which it can easily be distinguished by the way in which the veins of the underside of the hind wings are edged with green or grey green. The female lays her eggs on a number of cruciferous plants, weed plants and cultivated. The eggs are laid singly. The caterpillar is pale green, sometimes brown-green, but paler at the sides; there are dark tubercles with white hairs and white tubercles with dark hairs; there is no yellow line down the back; the spiracles are black with a yellow border. The pupæ are pale green and freckled; the two ends are brown. The Green Veined White is non-migratory.

Control of the Cabbage White.—When one has noticed the butterflies frequenting the plants, destruction of the egg clusters should be practised, if on a garden scale.

The caterpillars should be hand picked. The leaves should,

when the caterpillars have been noticed, and the earlier the better, be drenched with a solution of soap—soap 2 oz., water 1 gallon; or with weak brine—common salt 2 oz., water 1 gallon.

A Braconid parasite is a very useful natural aid against the caterpillars. This tiny four-winged insect named *Apanteles glomeratus* lays her eggs in the body of the caterpillar; sometimes as many as sixty eggs may be laid. From the eggs hatch legless maggots which devour the caterpillar's food reserve and later on spoil vital organs. When the *Apanteles* maggots are full grown they bore their way out through the muscle and skin of the unhappy caterpillar and then spin their cocoons, which remain attached to the outside of the caterpillar. The caterpillar dies, and the cocoons give exit in due course to a new brood of *Apanteles* parasites. It is no exaggeration to say that this little parasite is a very important check on the Cabbage White. Unfortunately it has enemies of its own.

SPECIAL AGRICULTURAL INDUSTRIES OF CANADA—II.

Ernest H. Godfrey, F.S.S.

Sugar Beet Cultivation.—Attempts to establish a beet-sugar industry in Canada were first made about 38 years ago, and for some time large beet sugar factories existed at various places in the province of Quebec under a system of bounties from the Dominion Government. Annual experiments at the Ontario Agricultural College, Guelph, from about the year 1889 demonstrated that the soil and climate of Ontario were suitable for the production of beetroots with a sugar percentage and a coefficient of purity equal to those grown on the European continent. Choosing localities with the other requisites of abundant water, transportation facilities, and a plentiful supply of labour, four beet sugar companies began operations in 1902 with the aid of a bounty provided by Act of the Ontario Legislature, bonuses voted by the ratepayers of Dresden (£8,000) and Wallaceburg (£6,000), and customs concessions from the Dominion Government for the importation of machinery. From 1903 to 1914 a sugar beet company was also in existence at Raymond, Alberta, and was aided by bounties provided by the Alberta Legislature for each of the five years ended 1910. During the first four years the tonnage of Canadian sugar beets increased from 51,067 in 1902 to 118,095 in 1905, and the value of the resulting sugar from £79,358 to £215,080. In the same period £296,905 were paid to farmers for beets delivered, £108,034 in wages to employees, and the value of the sugar manufactured was £561,492.

The bonus of the Ontario Government was *half a cent per lb.* and was paid from 1903 to 1907, when it expired. In 1909, when the Ontario beet sugar industry had been seven years in

operation, only two factories in Ontario and the single factory in Alberta remained active. In this year three of the Ontario factories came under the control of the Dominion Sugar Co., Ltd. These factories are situated at Chatham and Wallaceburg in the county of Kent, and at Kitchener, formerly Berlin, in the county of Waterloo. At present only the two Kentish factories are in operation. Kent, like its English prototype, popularly known as the garden county, is situated to the south of the Niagara peninsula, and, besides sugar beet, is noted for its agricultural production, especially fruits, tobacco and maize or Indian corn. For the two beet factories at Chatham and Wallaceburg it is claimed that the machinery installed for the manufacture of refined sugar is absolutely up to date, and that the equipment is unsurpassed by that of any other sugar factory in the world. The beets are grown on contracts with farmers in the counties of Essex, Kent, Lambton, Waterloo, Wellington and Huron, and every day during the sugar campaign, which lasts from October 31 to January 31, thousands of tons of beet are made into sugar in the plants of the Dominion Sugar Co. In an illustrated pamphlet issued by the company the numerous and varied processes from delivery of the beet to the shipment of four kinds of "Dominion crystal sugar" are interestingly described.[1] It is therein stated that throughout these processes, which include the cleaning, weighing and slicing of the beets, diffusion, carbonation and filtration, the turning of the beet juice into sugar crystals by centrifugal machinery, the whitening of the sugar, drying, cooling, grading and packing, no human hand comes into contact with the product, that everything is done by machinery, that no dyes are used, and that the most scrupulous cleanliness is observed. Every precaution is taken to ensure the absolute purity of the sugar.

The prices paid to farmers for the beets are based upon the average net selling price of the sugar and also upon the percentage of sugar in the roots; but there is a minimum price per ton for the roots of $6 at weigh stations and $7 per ton for waggon and truck delivery at the factories. For the year 1928 the contracts provided for payment of roots according to a scale ranging from $5 to $10 per 100 lb., based on the price of sugar and from 13 to 20 per cent. of sugar in the beets. Thus at a price of $5 per 100 lb. of sugar, beets with a sugar percentage of 13 received the minimum of $6 per ton (2,000 lb.), and the price rose to $8 per ton for a sugar percentage of 20. For the year 1928 the acreage of beets contrated for was 29,142. During the last three years the price of sugar has been very low, only about $5·25 per cwt. for fine granulated sugar in bags. The average test of the beets shows 15 per cent. of actual sugar in the roots. The average yield of roots is about 9½ short tons per acre.

It is generally recognised that the sugar beet crop is of great value in the farming rotation, besides which it requires and

[1] Sugar from Beet to Bowl, 8vo., 40 pp. Dominion Sugar Beet Company, Ltd., Chatham, Ontario.

justifies the employment of considerable labour for blocking, thinning, second hoeing and topping. For some years the price paid to labourers for these operations stood at $23 per acre. It has now been reduced to $21 (86*s*. 6*d*.), mainly owing to the low price of sugar.

Five years ago (1924) the sugar beet industry that formerly flourished in Alberta was revived by the establishment at Raymond of a new factory by the Canadian Sugar Factory, Ltd., and the acreage of roots grown for this factory has averaged about 6,400 during the last three years. For 1928 the area sown is reported as exceeding 7,000 acres, and the sugar beet company is desirous of seeing this area increased to 10,000 acres.

Finally, the following statement of the estimated average costs per acre of growing sugar beet in Ontario and Alberta, with the profit shown in each case, will be of interest :—

Costs of Production per acre of Sugar Beets.

Items.	Ontario.	Alberta.
	£ *s*. *d*.	£ *s*. *d*.
Rent and Taxes	1 10 0	1 13 0
Manure	2 12 9	...
Seed	0 17 3	0 17 3
Machinery	0 12 0	0 5 6
Manual labour	6 19 0	8 6 0
Horse labour	1 13 0	1 6 0
Totals	14 4 0	12 7 9
Value of roots	18 10 6	20 11 9
Profit shown	4 6 6	8 4 0

In the above statement manual labour is given as 135 hours at 25 cents per hour in Ontario and at 30 cents per hour in Alberta. The yield per acre is 9 tons for Ontario and 10 tons for Alberta, and the value $10 or 41*s*. 2*d* per ton in both provinces.

Tobacco-Growing.—Tobacco has been grown in Canada from quite early times, and there are records of tobacco made in Canada from Canadian leaf dating from 1871, or four years after Confederation in 1867. In 1871 the quantity so made was 46,791 lb., an amount which gradually increased to 2,523,936 lb. in the closing year of the nineteenth century, when also 1,686,140 cigars were made from Canadian-grown tobacco. About 20 years ago more serious efforts were made by the Dominion Government to encourage this industry. A tobacco expert from France was brought to Canada and a special Tobacco Division was formed of the experimental farm system at Ottawa to study the conditions of tobacco growing, ascertain the varieties best suited to the country, and issue cultural directions to growers. Steady work was done in these directions with increasing success. During recent years the area under tobacco in

Canada has greatly expanded, and it is generally considered that the future prospects are bright. Small quantities of tobacco are grown in several of the provinces, but only in Quebec and Ontario is there any considerable production. Within the last three years, however, attempts have been successfully made to extend the cultivation of tobacco to British Columbia, and the area in this province is now nearly 400 acres, as compared with 10 acres in 1925. Farmers, especially the "habitants" in the province of Quebec, have long been accustomed to grow tobacco for their own use. Generally it is smoked in pipes as raw leaf and as such is not subject to the excise duties payable on manufactured tobacco, cigars, cigarettes and snuff.[1]

The Census of 1901 showed that the area under tobacco in Canada was 11,906 acres and the production 11,267,000 lb. The area in 1927 was 44,028 acres and the yield 43,910,000 lb. For the year 1928 a preliminary report, issued on November 5th, placed the acreage at 43,138 and the yield at 40,956,375 lb. In Quebec the tobacco-growing counties are situated in the valley of the St. Lawrence river and around the large city of Montreal. In Ontario they are to the south of the province in the Niagara peninsula. The types of tobacco grown in the two provinces are distinct, those of Quebec being described as cigar binders and large pipe and small pipe, whilst in Ontario they are divided into Burley, Flue-cured, Green River and Dark-fired, including snuff. The total value of the Canadian tobacco crop of 1927 was about £1,822,400.

Tobacco now enters substantially into the export trade of the Dominion. For the fiscal year ended March 31, 1928, the exports of Canadian-grown tobacco were, in quantities and values, as follows:—

Exports of Canadian Tobacco, 1927-28.

Description.	Lb.	$	£
Unmanufactured	6,079,606	2,215,916	443,183
Stems and cuttings	442,100	9,147	1,829
Cigars	1,356	4,749	950
Cigarettes	9,950	11,913	2,382
Plug and twist	10,318	6,502	1,300
All other	209,987	54,374	10,875
Totals	6,753,317	2,302,601	460,519

Of these exports all but about 4 per cent. in value come to the United Kingdom.

As a consequence of complaints respecting unsold quantities of the tobacco crops of 1926 and 1927, a Commission to investigate and report on the conditions of the tobacco-producing industry in south-western Ontario was appointed by the

[1] The Canadian excise duties on tobacco are as follows:—tobacco, 20 cents. (10*d.*) per lb.; cigarettes, 3 lb. or under 1,000, $6 (24*s.* 8*d.*); cigarettes, over 3 lb., $11 (45*s.* 3*d.*) per 1,000; cigars, $3 (12*s.* 4*d.*) per 1,000; snuff, 20 cents. (10*d.*) per lb.

Dominion Minister of Agriculture on February 27, 1928. The Commission went thoroughly into all the conditions of the Canadian tobacco industry and presented their report during the year. They found that the unsold tobacco was largely of the lower grades, and their report was directed to secure improvements in the production of high grade tobacco both for the home market and for the surplus exported to Great Britain. The report stated that Canada can produce the finest quality of dark fire-cured tobacco, and recommended that every effort should be made to increase gradually the production of high-class leaf of this kind, which meets with distinct favour in Great Britain and which may replace the type now imported from Kentucky. A large variety of recommendations are contained in the report having application both to growers of the raw product and to the processing companies that manufacture for the home and British markets.

Floriculture.—The production of flowers and decorative plants on a commercial scale has had a great development with the growth of the larger cities during the last two or three decades. Although the first greenhouse in Toronto, and one of the first in Canada, was built in 1837, it was not until between 1870 and 1880 that there was any large area under glass anywhere in Canada, but during this decade considerable building was done. Low, narrow houses, with small glass fairly suitable for pot plants, gradually gave place to larger, lighter and better ventilated houses, as the cut flower trade increased. Also, the old method of heating with flues was replaced by hot water and steam and later by the self-feeding of fuel and other automatic devices.

The carnation became a popular florists' flower about the middle of the nineteenth century, and between 1860 and 1870 a great impetus was given by the introduction of improved varieties of carnations with longer and stiffer stems. Later, larger flowered sorts were introduced. Roses were not grown much under glass until the last quarter of the nineteenth century; but after that their popularity as cut flowers greatly increased. At present the most popular cut flowers in Canada are carnations, chrysanthemums, roses, sweet peas, antirrhinums, violets, lilies of the valley, and bulbs of various kinds.

According to the Census of 1921 the total area under greenhouse glass in Canada was then 9,957,243 square feet. More recently a survey by the Dominion Horticultural Council placed the area under glass in Canada for the year 1925 at about 22,548,800 square feet, of which 17,413,330 square feet were in the single province of Ontario.

About three years ago the Canadian Bureau of Statistics began the collection and publication of annual statistics of the floricultural and decorative plant industry. The report for the year ended May 31, 1927, showed that in this period rose trees and bushes for outdoor planting were sold to the number of 158,166, valued at £8,652, representing an average price per

tree or bush of 27 cents, or 1s. 1½d. Other ornamental trees, shrubs and bushes for outdoor planting were sold to the number of 2,042,312, valued at £81,051, an average of 19 cents or 9½d. each. The plants reported as sold in pots or other receptacles for greenhouse or indoor use numbered 900,621 of the value of £52,291. Of eleven varieties included in this category, geraniums were the most popular, numbering 265,560 of the value of £7,464, or at the average rate of £2 16s. per 100. Then in order come tulips 218,227, value £3,162; narcissi 124,618, £1,425; ferns 119,166, £18,911; lilies 47,423, £6,059; cyclamens 39,649, £5,033; primulas 34,375, £1,958; azaleas 19,268, £4,351; hydrangeas 18,361, £269; cinerarias 10,339, £777; and spireas 3,635, £459. Other ornamental plants, foliage plants, flowers and bulbs in pots, &c., for greenhouse or indoor use, numbered 259,452, value £4,590, an average of 9 cents or 4½d. each.

Flowering bulbs of all kinds sold as bulbs, including dormant bulbs imported and forced in Canada, numbered 2,013,460 of the value of £22,650, an average of 5 cents or 2½d. each. Of twelve named varieties of cut flowers the number reported as sold was 21,361,636 of the value of £322,759, the number not including but the value including "all other varieties." Amongst the cut flowers roses, carnations, sweet peas, lilies of the valley, tulips, daffodils and chrysanthemums are the most popular. The rose naturally predominates, the number of blooms sold being 7,290,586 of the value of £141,600, an average of 39s. per 100 blooms. Carnations numbered 4,195,950, £50,624; sweet peas 2,980,748, £11,625; lilies of the valley 1,479,086, £13,724; tulips 1,415,184, £16,018; daffodils 1,373,100, £14,107; and chrysanthemums 1,346,417, £24,302. Of the remaining flowers, the numbers reported as sold ranged from 443,299, £13,062, for Easter lilies down to 79,600, £191, for violets. The total value of the floricultural and decorative plant production by Canada during the year ended May 31, 1927, as represented by the statistics collected, was £491,993. In addition to the home production, cut flowers and florists' stock are annually imported, the value for 1926-27 being £35,593 for flowers and £179,905 for florists' stock.

As showing the great expansion of the Canadian floricultural industry during recent years a few particulars may be given of one establishment which is claimed to be the largest of its kind on the North American continent. This is known as the Dale Estate, Limited, and is situated at Brampton, near Toronto. The success of this company is largely due to the skill and enthusiasm of Mr. T. W. Duggan, who became manager in 1901 when the business was comparatively small and when the production of a whole year did not equal the present output of one day. In 1895 the area occupied by this firm under glass was 75,000 square feet. The space now covered by the conservatories is 35 acres. The total area of the farm is 250 acres and the employees number 375. The large central heating plant has a capacity of 5,000 boiler H.P., and the annual coal

consumption is 15,000 short tons. On the farm are 125 head of cattle kept mainly for fertilising purposes. In the greenhouses are plants of some 225,000 roses, 160,000 carnations, 2,000,000 lilies of the valley, 1,000,000 Dutch bulbs, 225,000 chrysanthemums, 50,000 orchids, and 100,000 Easter lilies. Four acres are devoted to asparagus, and the annual production of hothouse tomatoes is 100 tons. Altogether something like ten million blooms are sold annually. All but 5 per cent. of the total products are sold in Canada. The company has done much to popularize exotic blooms, and especially orchids, the price of which has been brought within the means of the average Canadian business man. Two new roses recently produced by this firm and known as the "Lady Canada" and the "Lady Willingdon" have received widespread admiration.

Value of Industries described.—In conclusion, it may be stated that the total annual revenue derived from the seven industries described is nearly £60,000,000, the amount varying from year to year according to the season and economic conditions. For the year 1927 the values may be estimated as follows:—Dairying, £50,513,000; fur farming, £725,000; fruit growing, £3,688,000; Maple products, £1,015,000; sugar beet, £500,000; tobacco, £1,875,000; floriculture, £492,000,—Total, £58,808,000.

In addition to the field crops, the value of which, as stated at the beginning of this article, is about £230,000,000, other items of agricultural revenue include live stock, wool, vegetables, poultry, eggs, flax fibre, clover and grass seed and hives and honey. Altogether, the Canadian agricultural revenue from all sources amounted for 1927 to about £357,292,000.

THE NUTRITIVE REQUIREMENTS OF POULTRY.

VII. GROWTH IN CHICKENS—II.

M. Moir, *Rowett Institute;* H. Newbigin, *East of Scotland College of Agriculture;* A. Kinross, *West of Scotland College of Agriculture;* and G. Scott Robertson, *Ministry of Agriculture and Queen's University, Belfast.*

In a previous communication to the Scottish Journal (Vol. IX, October, 1926) the results were given of preliminary chicken feeding experiments which showed that a very poor rate of growth was obtained if the ration fed to chickens consisted entirely of cereals and cereal products. Such a ration is deficient in certain nutritive factors required by the chick for constructive purposes, particularly as regards its content of mineral matter, and possibly also with regard to the quality of its protein. The addition of milk, however, to the cereal ration was accompanied by a very marked increase in the rate of growth, and this was obtained

irrespective of whether whole or separated milk was used. Similar results have been obtained in feeding experiments with school children in which separated milk proved to be as valuable for growth as whole milk. Such results seem to point to the fact that the value of separated milk as a foodstuff has been underestimated. Besides being relatively inexpensive, it contains nearly all the nutritive factors of whole milk; the fat only being absent. Beneficial effects on growth in chicks were also obtained by the addition to the cereal ration of substances rich in animal protein and mineral matter and also of various vegetable proteins supplemented by artificial mineral mixtures, but it was evident that the best source of the extra protein and mineral salts required was milk. The results obtained in these preliminary experiments, particularly as regards the nutritive properties of separated milk, were deemed of sufficient practical importance to warrant further confirmation, and a second series of experiments was carried out on similar lines with certain amplifications.

In most of the experiments discussed here, one group of chickens was fed the basal ration consisting of cereals and cereal products. In certain of the experiments, however, this basal group was omitted as the previous experiments had shown the unsatisfactory rate of growth and high mortality on such a ration. To the basal ration of each of the other groups various supplements were added. In all experiments the chicks were from three days to one week old at the beginning of the test, were closely related and kept under good conditions with a grass run. The cockerels were removed from the experiments as soon as the sex of the birds could be determined. There are two experimental periods therefore in each test, the first (*A*) relating to the mixed group, the second (*B*) to the pullets after separation. In several of the tests, however, sex-linked chicks were used, i.e. chicks whose sex can be determined at hatching, and in these there is only one experimental period.

Table I shows the effect of the addition to the basal ration of milk, either whole or separated, and of meat and bone meal. The figures in brackets refer to the number of chicks in the various groups.

TABLE I.

Experiment.	No of Days.	Average Gain in Weight per Bird in grams.			
		Basal Ration.	Basal + Whole Milk *ad lib.*	Basal + Separated Milk *ad lib.*	Basal + 10% Meat and Bone Meal.
I *A*. Mixed [25]	103	811	1,468	1,677	1,404
I *B*. Pullets	42	423	328	403	219
II *A* Mixed [45]	42	150	411	405	334
II *B*. Pullets	91	...	1,258	1,333	1,285
III. Sex linked [20] ...	119	1,188	1,746	1,725	1,475

It will be seen that in all experiments the groups receiving the additions grew much faster than those on the basal ration alone. In experiments I and II growth in the separated milk group was superior to that in the whole milk group over the whole period. In experiment III increases in weight in the milk groups are almost similar. These results confirm those of the preliminary investigation as to the value of separated milk in rearing chickens. The addition of meat and bone meal has resulted in an increased rate of growth as compared with the basal group, but this increase was in each case definitely lower than that of the milk groups.

Two experiments were carried out using semi-solid buttermilk to replace separated milk and goats' whole milk instead of cows' milk. The results of these tests are shown in Table II.

TABLE II.

EXPERIMENT.	No of Days.	Average Gain in Weight per Bird in grams.			
		Basal Ration.	Basal + Whole Milk (Goats) *ad lib*	Basal + Semi-solid Buttermilk.	Basal + 10% Meat and Bone Meal.
I *A*. Mixed [15] ...	50	149	454	413	433
I *B*. Pullets	39	236	488	489	441
II. Sex linked [10] ...	147	1,404	2,095	1,795	1,647

Here also the best rate of gain over the whole experiment was found in the milk groups, in the first experiment smaller gains being obtained with semi-solid buttermilk than with whole milk. The addition of meat and bone meal to the basal ration has been followed by an increased rate of growth, but considerably less than in the case of either of the milk groups.

In addition to whole milk, separated milk and semi-solid buttermilk, other varieties were tried. These were dried milk and a synthetic milk consisting of sugar of lime and a "lecithin product." The rates of gain in groups receiving these additions are shown in Table III, and for comparison the figures for the basal and separated milk groups (Table I) are repeated.

TABLE III.

EXPERIMENT.	No. of Days.	Average Gain in Weight per Bird in grams.			
		Basal Ration.	Basal + Separated Milk *ad lib.*	Basal + 10% Dried Milk.	Basal + Synthetic Milk.
I *A*. Mixed [25]	103	811	1,677	1,337	1,207
I *B*. Pullets	42	423	403	366	343

Over the whole experiment both the dried and synthetic milks gave increased rates of growth as compared with the basal ration of cereals, but in neither case did the gains made approach those of separated milk. The dried milk gave better results than the synthetic milk. It will be seen that after the separation of the pullets and cockerels the best rate of gain was made by the basal ration group, although up till that time growth in this group was much slower than in the other groups.

In the second series of experiments attempts were made to balance up the basal ration by the addition of either mineral matter, substances rich in both protein and mineral salts, or various vegetable proteins supplemented by mineral mixtures. Groups receiving these additions were compared with groups having separated milk as a supplement. The mineral mixture used to balance up the basal ration consisted of steam bone flour 80 parts, potassium chloride 16 parts, sulphur 2 parts, ferric oxide 0·8 part, and potassium iodide 0·08 part. In two of these tests the basal ration group was omitted for reasons previously mentioned. Table IV shows the rates of gain in groups receiving either separated milk, mineral matter or fish meal as a supplement.

TABLE IV.

Experiment.	No. of Days.	Average Gain in Weight per Bird in grams.			
		Basal Ration.	Basal + Separated Milk *ad lib.*	Basal + 3·75% Minerals.	Basal + 5% Fish Meal.
I *A*. Mixed [100]	35	...	271	206	247
I *B*. Pullets ...	98	...	1,105	1,022	1,037
II. Mixed [40]	140	...	1,215	1,073	1,069
III *A*. Mixed [57]	91	623	1,436	1,114	1,234
III *B*. Pullets ...	42	...	540	633	551

It will be seen that in the only test in which the basal ration alone was used, growth was very poor as compared with growth in groups receiving the additions. It may be mentioned here that the birds in this basal group were about seven weeks later in coming to the laying stage than any of the other groups. Over the whole period of the experiment the best growth was obtained in each case by the use of separated milk. The addition of mineral salts and of fish meal gave increased rates of gain over the basal group but less than the separated milk group, and it is of interest to note that the gains made by the mineral and fish meal groups are almost similar, indicating the importance of the mineral fraction of the fish meal.

In addition to these supplements, various other additions of proteins supplemented by mineral mixtures were tried and also an intensive feeding ration, the composition of which varied according to the age of the chickens. For the first week this

intensive ration consisted of bran (86 per cent.), together with fish meal, dried buttermilk and steam bone flour. Up to the thirteenth week there was a gradual reduction of the amount of bran and an increase in the amounts of the other components with the introduction of maize, oats and sharps. After the thirteenth week the ration consisted of equal parts of bran, maize and oats. Table V shows the rate of gain in the various groups, the figures for separated milk being repeated for comparison.

TABLE V.

EXPERIMENT.	No. of Days.	Average Gain in Weight per Bird in grams.			
		Basal + Separated Milk *ad lib.*	Basal + 6 5% Soya Meal + 3 13% Minerals.	Basal + 2% Earthnut + 2% Soya Meal + 3% Linseed + 3 13% Minerals.	Intensive Mixture.
I *A*. Mixed [100]	35	271	228	207	250
I *B*. Pullets ..	98	1,105	955	1,078	1,096
II *A*. Mixed [40]	140	1,215	1,064	...	..
III *A*. Mixed [57]	91	1,436	1,272	1,135	1,393
III *B*. Pullets ...	42	540	571	597	442

Separated milk proved the best addition to the basal ration. In the first experiment, however, the group on the intensive ration gave almost as good results. In the third experiment this effect of the intensive ration was repeated up to the time of the separation of the cockerels. After the separation this group was by mistake put on to the basal ration, which accounts for the subsequent drop in the rate of gain as compared with the other groups. Good results were also obtained by the use of vegetable proteins and mineral supplements, but not so marked as in the case of separated milk.

Summary and Conclusions.—1. As a result of further experiments with chickens to test the value of the addition of various supplements to a ration of cereals, the tentative conclusions arrived at in the previous paper have been confirmed, particularly as regards the beneficial effect of feeding milk to chickens. It has again been shown that separated milk is as valuable for growth as whole milk. Other forms of milk, including semi-solid buttermilk, dried milk and a synthetic milk, proved valuable as supplements, but the rates of gain were definitely less than on either whole or separated milk.

2. Beneficial results were also obtained by the addition of substances rich in animal protein and mineral salts such as fish meal or meat and bone meal, although the rate of growth was on a lower level than that obtained by the use of whole or separated milk. In certain experiments vegetable proteins supplemented by mineral mixtures gave as good results as fish meal. Similar results were obtained by the addition of mineral

salts alone, and it would thus appear that the value of fish meal as a foodstuff is associated particularly with its mineral constituents.

3. An intensive feeding ration, the composition of which varied according to the age of the chick and which at the beginning contained 86 per cent. of bran, gave almost as good results as separated milk, and it would appear that this ration approaches more closely to the composition of milk and is more suited to the requirements of the chick than any of the other rations tried. A further investigation of this ration is proceeding.

Note.—The authors are indebted to Mr. J. S. Thomson, Rowett Research Institute, who kept and summarised the records of these joint experiments and prepared this paper for publication.

THE BIOLOGIST on the FARM.—No. XXXIV.

Professor J. Arthur Thomson, M.A., LL.D.,
University of Aberdeen.

Why not grow Musquash?—Very widely spread in North America is a cousin of our water-vole, called the musk-rat or musquash, *Fiber zibethicus*. It is interesting in many ways, in its laterally compressed tail, in its dome-like house of bulrushes, in its partly carnivorous diet, and so on. It has a pleasant and beautiful fur, which is sold under many names and requires no apology. This commercial value led in 1905 to the experiment of introducing the muskrat into Bohemia. The reasonable idea was to have musquash farms; but the introduction has been so successful that it has proved a curse in disguise. The colony multiplied and overran mid-Bohemia. About 1914 Bavaria and Saxony were invaded; in 1924 Silesia; and in 1928 the outposts were still spreading. In 1921 over 60,000 musquash skins of European origin were sold in Berlin! As might have been expected from such warnings as the rabbits in Australia, the prolific rodents are becoming very serious in their disturbance of the Balance of Nature. They have attacked corn, potatoes, kohlrabi, turnips and carrots. They have turned their attention to frogs and fishes. Their burrows have done damage to the banks of roadways near the water. In short, the musquash has been making a sorry tangle of the web of life, telling us afresh that no introduction to a fauna should be made without a careful weighing of the pro's and con's. Yet at the present moment in this country we are tolerating not only our millions of alien rats, but a menacing increase in the number of grey squirrels, gratuitously introduced from America. No; we cannot recommend musquash farms.

Albinism.—In a regional exhibition held this summer in Aberdeen the Natural History section included some interesting local

albinos. Thus there was a snow-white water-vole or water-rat, which we take to be very unusual. What a sensation it must have made during its lifetime. There was also what seems to be an albino stoat, differing from an ermine (the winter form of the stoat) in having no black tip to the tail. We did not see the eyes of the living animal, a sure index of inborn albinism, for the absence of pigment in the iris allows the red blood to shine through. Another interesting exhibit was a white puffin, which we take to be a colour-variety, not exactly an albino. There was also a white mole, which is probably an illustration of true albinism.

What does this apparently pedantic distinction mean? The answer is not difficult. A Polar bear is more or less white, but it is very far from being without pigment. An ermine is white except the tip of its tail, but the blackness of the terminal tuft forbids any thought of albinism. So in other cases of normal whiteness where the iris shows the usual pigmentation. The whiteness is of course due to the uniform and practically total reflection of the light from the mirroring vacuoles in the substance of the feathers or hair where pigment should normally be. But that is not the point just at present. when we are contrasting normal whiteness with albinism, which means total absence of pigment, as in white mice, white rats, white blackbirds, white crows, and so forth.

To what is albinism due? Dark pigments (melanins) are produced in animals by the action of a ferment, tyrosinase, on an amino-acid, tyrosin. The ferment is a common one, and amino-acids are produced in abundance by the breaking down of the proteins which form part of the food. So it is easy to understand the frequency of dark pigments or melanins among animals. But what causes an albino? The probable answer is that the hereditary factor or " gene " corresponding to tyrosinase is lost in the maturation of the germ-cells, in the course of spermatogenesis, and in the formation of the first polar body by the ovum. If the factor for tyrosinase is not supplied by either parent, then albinism must result in the offspring. It behaves as a recessive character in Inheritance.

The Manoilov Test for Sex.—The Biologist on the Farm has previously referred to the interesting tests for sex which have been proposed by Manoilov and by others. The addition of certain chemical reagents to the blood or to the expressed extracts of various kinds of organisms has for its final result a certain colour for the male and another colour for the female. In short, the sex can be told from the colour in the test-tube containing the blood, or extract, or even sap. Now the difficulty has been that while some experimenters, such as Manoilov and his collaborators, are extraordinarily successful in applying this test for sex, others get conspicuously discrepant results. Thus half a dozen determinations may prove quite correct, while in the next half dozen three are right and three are wrong.

A recent investigation by Professor Oscar Riddle and Dr.

Warren H. Reinhart has led to a suggestion which seems to us very shrewd. The suggestion is that the colour difference is primarily an index of the rate or intensity of the metabolism. Thus blood from younger birds, with a high basal metabolism (or routine of essential vital processes), gives a lighter colour than blood from older birds. Aqueous extracts of active tissues (muscle, heart, gizzard) in doves yield a colour lighter than that given by tissues presumably less active, such as those of the liver. The glands of the bird's oviduct yield a lighter colour when actively secreting, and a deeper colour the further they are removed from active functioning. Similarly extracts of whole embryos give the lightest colour when prepared from freshly killed embryos; but decidedly darker when prepared from embryos which have been dead for one to three days. Thus the reason for the discrepancies in previous experiments, in which we have shared, may be that the physiological state, in particular the metabolic intensity, varies notably from one individual to another and at different ages and seasons.

This fits in well with the metabolic theory of sex stated in 1889 by Geddes and Thomson in "The Evolution of Sex." According to this theory, the ratio of Anabolism (constructive processes) to Katabolism (down-breaking processes) is always relatively greater in the females. In the male constitution there is a relative predominance of Katabolism. That is to say, the ratio $\frac{A}{K}$ in the female is fundamentally greater than the ratio $\frac{a}{k}$ in a male of the same weight. It is not, of course, inconsistent with this that there should be, as there often is, a difference in the chromosomes of the nucleus in the two sexes. The chromosomal difference may be an index of a physiological or biochemical difference which goes deeper. It should never be forgotten that one and the same animal may change its sex in the course of its lifetime, and sometimes does so normally,—a fact which is distinctly in favour of the physiological interpretation.

But what we are concerned with at present is the suggestion made by Riddle and Reinhart that the Manoilov reaction is a better indicator of metabolic rate than of sex, and that the reason why it often works correctly in determining the sex from the blood or the extract is to be found in the radical relation between metabolism and sex. "The numerous studies that have been made on plants and animals with the Manoilov test have notably extended the evidence for the metabolic theory of sex."

Can we control Sex?—Not many years ago it would have seemed very "academic" to discuss the validity of the Manoilov test for sex, or to speak about chromosomes in their relation to the sex of calves and chickens on the farm. But we are not so narrow-minded nowadays, especially since it has been proved up to the hilt in instance after instance that very theoretical investigations are often of the highest practical importance. As Bacon said, they are fruit-bearing as well as light-bringing.

Now from several sides the citadel of sex is being stormed, and the theoretical questions to which we have been referring

are essential parts of the attack. Suppose it be true that the sex of the offspring depends primarily on the rate and rhythm of the metabolism (or essential biochemical routine) in the egg-cells and sperm-cells, then it may be possible to sway the metabolism to one side or the other by altering the influences that play upon the germ-cells. It may be possible to speed up or slow down the oxidations of the egg or of the developing embryo. In some lower animals this has already been done in various ways, and it may now be said that sex is theoretically transformable or controllable. And apart from the possibility of getting twelve cockerels to the dozen, and all that sort of thing, a deeper physiological understanding of sex may lead to methods of correcting sex-deficiencies or sex-exaggerations in human beings. We quote a couple of sentences from one of Professor Riddle's recent papers :—" Very diverse and special methods have been used in controlling sex in several animals, but these are at present largely or wholly inapplicable to the human and other mammals. Yet if the ultimate effects of these several methods are reducible to changes in what is known as metabolic rate, we can later hope to employ in man and mammals other and new agencies which can act directly and specifically on metabolic rate in the egg and embryo."

How Spermatozoa reach the Ova.—Here is one of the simplest of questions : how it is that spermatozoa, introduced by the male into the lower part of the female genital tract, manage to make their way to the upper part of the oviduct, such as the Fallopian tube. It was in 1843 that Martin Barry, a medical student in Edinburgh, was first able to demonstrate for a mammal (the rabbit) the fertilisation of the ovum by a spermatozoon within the oviduct, but how the spermatozoa reach the ova is still obscure. The interior surface of the female duct is lined with cilia which beat vigorously towards the distal end, and are reasonably believed to assist in the downward passage of the egg-cell, in a bird for instance. But if the cilia beat strongly towards the lower end of the duct, how do the microscopically minute spermatozoa make their way against the stream?

Various suggestions have been made. Thus it is said that the constitution of the sperms is such that they go against a current, just like elvers going up the river. In other words, their tropism is to move against a current; and of this there is some experimental evidence in cases where the current is not too strong. But here it is interesting to notice the remark of Professor G. H. Parker of Harvard, whose investigations are always very suggestive : " No one can have examined the ciliary current in a living oviduct without having been impressed by its vigour. In fact so strong is it that I have never been able to convince myself that spermatozoa could make headway against it, and yet these cells must, by one means or another, reach the proximal end of the oviduct in the neighbourhood of which the egg is fertilised."

It has also been suggested that the seminal fluid may bring about a reversal of the ciliary current, so that it helps the spermatozoa up the oviduct. Such a reversal is known in other cases, but there is no experimental proof that it occurs in the oviduct. Nor is there any proof that muscular movements of the wall of the oviduct itself are able to force the sperms in the effective direction.

Faced by these difficulties, Professor G. H. Parker has recently studied the oviduct of the Painted Turtle, Chrysemys picta, and has made an interesting discovery. The oviducts of the turtle possess two systems of cilia : a general system covering most of the interior of the duct and beating away from the ovary (abovarian system), and a restricted narrow tract of cilia extending the length of the duct and beating toward the ovary (proövarian system). Thus spermatozoa reach the ovarian end of the oviduct not by their own activity, nor by the muscular movement of the oviduct, nor by the reversal of the ciliary beat in this duct, but by transportation afforded by the proövarian ciliary tract.

We hope that no one will be shortsighted enough to say : This is all very curious, but what have farmers to do with Painted Turtles? That would not be a wise question, for the next step is, of course, to discover whether there is a double ciliary system in the oviduct of birds and mammals. If the down-current is too strong for spermatozoa to make their way against the stream, then we do not know how the intimate fertilisation is effected in sheep and cattle and horses and poultry. But if Parker's discovery of a narrow tract of proövarian cilia in the turtle is corroborated in mammals and birds, then another obscurity disappears.

COLOUR SELECTION OF SEEDS BY CHICKS.

H. F. Newbigin, N.D.D.,

Edinburgh and East of Scotland College of Agriculture; and

R. G. Linton, M.R.C.V.S.,

Dept. of Hygiene, Royal (Dick) Veterinary College.

In a previous paper[1] we discussed the natural selection of seeds by chicks and showed that certain seeds, split lentils, peas and maize, which were more brightly coloured than the others, were not favoured by the birds. From that test the following questions arose :— (*a*) Can chicks when started on a mixed food from the day of hatching distinguish colours? (*b*) If so, have they any colour preference or dislike? The present experiment

[1] The Palatability of Certain Seeds to Chicks. H. F. Newbigin and R. G. Linton. *Scottish Journal of Agriculture*, vol. x, No. 4, October 1927.

was undertaken with the hope that it might throw some light on the problem of food selection and help to determine if the rejection of lentils, peas and maize by young chicks in our previous experiment was due to aversion on the part of the birds to brightness of colour or if it was due to some other factor, e.g. taste.

Twenty cross-bred sex-linked cockerels were hatched on January 3rd, and two days later were supplied with the mixture to be tested. The foods used were dari, millet, canary seed and hemp, all being given in the uncrushed state. The dari was divided into seven portions which were stained respectively yellow, red, blue, purple, green and black, while one lot was left the natural colour. The staining was limited to the seed-coats, very little penetrating to the endosperm. There was difficulty in obtaining a dead black seed, and the final colour was rather a dark brown than black, being very similar to that of Sesbania seed, *Sesbania cinarascens*. The red coloration was nearer a bright pink than a true red. The millet, canary seed and hemp were supplied in order to provide food other than dari, and were selected partly because a previous experiment had shown that they were popular foods, and in part because they would be easily picked out in the final separation of the residues. The mixture was made up in the following proportions :—

Dari	35
Canary seed	25
Millet	25
Hemp	15
	100

The 35 per cent. of dari was made up of 5 per cent. of each of the colours. The mixture was placed in a box to which the chicks had constant access, a method which we had found satisfactory in a previous experiment. The quantity of the mixture given was such as to ensure that selection by the chicks would be free and not restricted by a shortage of any one seed; it ranged from 100 grams on the second day to 500 grams on the twenty-first and concluding day of the experiment, and throughout the trial the residue at the end of each day was more than 50 per cent. than that given at the beginning of the day, with the exception of four days during the early part of the trial, when it was slightly below. The residue was collected at the end of each day and sent to the laboratory for examination. It was cleaned of bird droppings and bits of straw from the floor of the pen and weighed; the whole residue was divided up into its component parts, which were weighed, and as the weight of the seeds given at the beginning of the day was known, it was thus possible to calculate the percentage of each food eaten daily by the birds.

The choice of foods by the chicks during the first three days

was erratic, which indicates that at this early age chicks possess but little discriminating power. In a previous experiment it was found that selection was fairly definite on the second day of feeding, i.e. the third day after hatching. In calculating the averages, the results of the first three days are not included. The percentage of each food eaten day by day is given in the accompanying table. The total quantity of food given to the

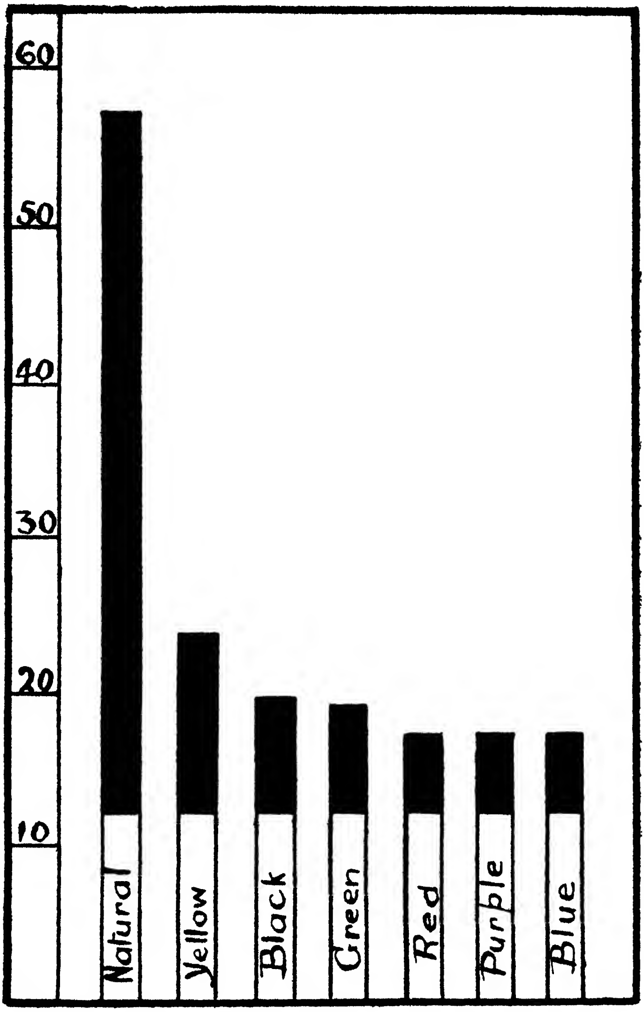


Chart showing the average percentage (for twenty-two days) of natural and coloured dari consumed by the chicks.

chicks was increased periodically, on the third day from 100 grams to 200 grams, on the tenth to 300, on the fourteenth to 400, and on the twenty-first to 500 grams. The percentages of the residues are therefore given in sectional form because as the quantities of food supplied were increased the percentage consumed would naturally tend to decrease immediately after. As,

however, each food was increased proportionately the one to the other, and as the object of the test was to determine, if possible, the relative attractiveness of, or aversion to, various colours, the periodic increases in the quantity of foods given does not adversely affect the results.

Percentage of each Food eaten of that given Daily.

Day.	Dari.							Hemp.	Millet.	Canary.
	Natural.	Yellow.	Red	Black.	Green.	Purple.	Blue.			
1.	*nil*	70	36	20	26	9	24	58	82	56
2.	98	85	36	*nil*	27	6	*nil*	73	99	88
Average	49	77·5	36	10	26·5	7·5	12	65·5	90·5	72
3.	8	11	*nil*	16	18	1	11	*nil*	60	12
4.	70	33	13	14	5	19	21	17	95	91
5.	89	35	21	23	21	26	26	27	66	52
6.	91	44	19	21	33	26	25	32	72	76
7.	48	13	11	21	16	6	21	44	74	67
8.	63	20	23	29	37	29	22	52	64	67
9.	80	26	34	25	31	28	31	62	76	74
Average	73	28	20	22	24	22	24	39	74	71
10.	45	24	19	12	20	18	19	41	55	55
11.	52	21	9	16	16	14	17	41	70	59
12.	70	26	24	27	18	28	8	48	59	62
13.	65	25	16	21	21	14	12	51	66	64
Average	58	24	17	19	19	18	14	45	62	60
14.	72	18	14	12	15	11	15	41	65	56
15.	49	34	18	23	18	20	26	55	54	56
16.	88	21	13	20	18	3	29	47	52	49
17.	69	32	11	20	14	18	8	47	65	52
18.	33	18	13	8	11	4	9	81	60	51
19.	48	30	10	20	11	16	3	44	72	59
20.	47	24	6	10	6	10	8	64	69	65
Average	58	25	12	16	12	12	13	54	62	55
21.	40	22	22	21	15	18	18	57	60	50
22.	38	9	16	16	18	16	13	59	61	57
Average	39	15	19	18	16	17	15	58	60	53
General Averages	57	23	17	19	18	17	17	49	64	60

A study of the table will show that from the fourth day to the end of the experiment the chicks had a definite preference for the natural dari, consuming from three to four times the quantity of this to any coloured grain. This preference was quite definite and was clearly indicated each day after the third. While there was considerable variation in the selection of the various colours from day to day, on one occasion only did the *maximum* amount of a coloured grain equal the *minimum*

quantity of natural grain consumed. Of the coloured grains, yellow was eaten to a slightly greater extent than any other colour, but the difference is not very great. It may be that the choice of yellow is inherited, maize being a very common constituent of the grain mixture of hens. It will be seen from the table that the chicks consumed the red, black, blue, green and purple seeds in equal quantities, showing no preference or distaste for any particular colour. We have no explanation to offer for this except that the consumption of these grains was more or less accidental; that in fact, when the twenty birds were fed in the box at the beginning of the day, they took for preference the seeds without conspicuous colours—dari, hemp and millet, and that during the stress of competitive eating, when first given food, their second choice was yellow and thereafter any other colour. One may perhaps assume that if there had been no competition for grains at feeding time, that is had it been possible to feed each bird separately, a still greater proportion of the brightly coloured grains would have been left uneaten. Human taste could not distinguish any difference in the palatability of the various coloured grains, but this does not necessarily imply that the dyes used would not impart a distinctive taste recognisable by the chicks, but this does not seem probable.

Egg Production in Caithness and Orkney.

MR. ALEXANDER F. SMITH, egg marketing officer to the Department of Agriculture, has contributed the following notes on egg production in the areas of Caithness and Orkney.

Caithness.—Although Caithness may not be regarded by many people as an important egg producing area, it is nevertheless of considerable importance in this connection. The county has no special features which would appear to make it specially suitable for egg production, the limiting factors being lack of shelter, distance from market and, in some areas, a cold damp soil. In spite of these disadvantages, however, poultry keeping is an important asset to the county and, in view of the very considerable income derived from the export of eggs, is worthy of an increased amount of support.

By the courtesy of the District Traffic Superintendent of the London, Midland and Scottish Railway, and of the local agents of the North of Scotland Steam Navigation Company, figures showing the export of eggs by rail and sea during 1927 have been secured. These figures do not include eggs sent by post or taken personally by individuals travelling south.

The chief markets for Caithness eggs are Inverness, Perth, Dundee, Glasgow and Edinburgh. The bulk of the eggs are sent by rail. Both the rail and shipping rates may be regarded as reasonable, and compare very favourably with the freight charges on the west coast of Scotland.

The following table shows the export month by month during 1927 :—

January	17,760	dozens.
February	35,130	,,
March	91,450	,,
April	94,540	,,
May	96,580	,,
June	86,720	,,
July	57,680	,,
August	38,380	,,
September	30,000	,,
October	15,470	,,
November	10,160	,,
December	20,670	,,
Total ...	594,540	dozens.

It will be noted that the total for the months of March, April, May and June represents 62·1 per cent. of the total, while the total for the months of January, October, November and December represents only 10·7 per cent. of the total export for the year. These figures suggest that there could with great advantage be some levelling up of supplies during the winter months when prices are at their highest, although the cold and exposure to which the poultry are subjected during that period materially affect production.

It is not possible to arrive at an absolutely accurate figure showing the quantity of eggs consumed in the county, but an approximate figure may be arrived at on the basis of a local consumption of 13 dozen eggs per head of the population per annum. With a population of 28,285 this would give a total of 367,700 dozen.

The total production for Caithness would be :—

Exported	594,540	dozens.
Consumed locally	367,700	,,
Total ...	962,240	dozens,

which at 1*s*. 4*d*. per dozen would give a sum of £64,150, of which exports represent £39,636.

The gross valuation of Caithness, including Wick and Thurso, is £107,536, and the agricultural valuation approximately £55,500, which is £8,650 less than the value of the eggs produced in the county.

Orkney.—Orkney occupies the foremost place in Scotland in regard to density of poultry per 100 acres of arable land. It is

difficult to explain why this should be so, although various reasons have from time to time been advanced by those who claim to have knowledge of the subject. Such reasons include the prevision and foresight of certain merchants, the development of co-operative methods of trading on the part of producers, the suitability of the islands owing to a fairly equable temperature, and so on. The prominent position which Orkney holds as an egg producing area is probably due to a combination of causes in addition to those already enumerated, and is in large part due to the vision of the local farmers, who in a peculiar degree are ready to try anything calculated to be of financial advantage.

The first record of the export of eggs from Orkney was in 1805, when five boxes of eggs were sent off. In later years exports were as follows :—

		Dozens.	*Value.*
1833	... ...	100,000	£2,500
1861	... ...	500,000	12,500
1871	... ...	860,500	25,100
1881	... ...	998,500	33,300
1895	... ...	1,764,700	58,800
1912	... ...	1,853,200	87,600

From the above table it will be seen that egg production on a large scale is no new thing in Orkney, and that even 50 years ago the export of eggs had reached considerable dimensions. During the last three years the export has been as folows :—

		Dozens.		*Value.*
1926	...	2,495,217	at 1*s*. 4*d*.,	£166,348
1927	...	2,598,211	at 1*s*. 4*d*.,	173,214
1928	...	2,481,229	at 1*s*. 4*d*.,	165,415

Practically the entire output of eggs from Orkney is shipped to Leith, and the freight charges work out at rather under ½*d*. per dozen.

During the last few years a considerable improvement has been made in the packing of eggs for despatch, but there is still great room for improvement, the cases too often being in a condition that does not enhance the value or attractiveness of their contents.

The purchase of eggs by weight is now being fairly generally adopted and is a decided step forward, as by this means producers of large eggs receive a fair return for their better class produce. To the Orkney Egg Trade Association credit is due for this reform, and also for the useful efforts made to encourage testing, grading and improved methods of packing.

The total export taken month by month during 1928 was made up as follows :—

January	... ...	88,627 dozens.
February	... ...	111,916 ,,
March	... ...	285,408 ,,
April	... ...	411,723 ,,
May	... ...	383,018 ,,
June	... ...	304,074 ,,
July	... ...	288,932 ,,
August	... ...	199,000 ,,
September	... ...	148,165 ,,
October	... ...	106,749 ,,
November	... ...	62,951 ,,
December	... ...	90,666 ,,
	Total ...	2,481,229 dozens.

Of the above, the export during March, April, May and June represents 55·7 per cent., as against 14 per cent. for the months of January, October, November and December.

On the assumption that the population is the same as that recorded at the last Census (1921), namely 24,111, and that 17 dozen eggs is the average consumption per head per annum, then the total production would work out :—

Exported	... ...	2,481,229 dozens.
Consumed locally	... ...	409,887 ,,
	Total ...	2,891,116 dozens,

which at 1*s*. 4*d*. per dozen would show a total value of £197,740.

A comparison of this figure with the valuation of the county may be of interest. The gross valuation of Orkney for 1928 was £74,600, of which the agricultural valuation amounted to £50,630. During the year under review the value of the eggs produced in the county exceeded the gross valuation by a sum of no less than £123,140.

An abstract made of the position in one of the smaller islands, namely Burray, brings out the following position. In 1928 the export of eggs was 42,960 dozen. With a population of 410 and on the basis of an average local consumption of 17 dozen per head per annum, the total production would be :—

Exported	... ...	42,960 dozens.
Consumed locally	... ...	6,970 ,,
		49,930 dozens.

At 1*s*. 4*d*. per dozen this would give a figure of £3,329, or over four times the gross valuation of the island, which is £817.

To agriculturists who are frequently inclined to regard poultry

keeping as of little or no importance the following comparisons may be enlightening.

During 1928 the total value of all the pure-bred Shorthorn and Aberdeen-Angus cattle sold by public auction in Scotland was £182,635, which was roughly £15,000 less than the value of the eggs produced in one small county, namely Orkney, which exported eggs to the value of £42,000 in excess of all the pure-bred Shorthorn, Galloway, Highland, Ayrshire and Friesian cattle sold by public auction in Scotland in that year.

A good deal is heard of the ever increasing competition on the home market of produce from overseas, yet in 1927 the value of the eggs imported into Great Britain from all parts of the British Commonwealth of Nations, excepting the Irish Free State and British South Africa, was £15,000 less than the Orkney export, which exceeded by 440,000 dozen the total imports of eggs from the whole American continent, including Canada, the United States of America and South America.

Black Discoloration in Cheese.

THE following article has been contributed by Professor R. H. Leitch, M.A., B.Sc., of the West of Scotland Agricultural College.

During the past two years a defect known as black discoloration in cheese has appeared with increasing frequency, not only among Scots Cheddars, but also in Cheshires and other English coloured cheeses. This defect, which renders cheese practically unsaleable, is characterised by the presence in the cheese of small isolated blackened areas with intense black centres, varying usually in size from pin points to the size of peas, but occasionally attaining much larger dimensions. Many affected cheeses show in addition a diffuse blackened or smoky appearance throughout the substance of the curd which makes them altogether objectionable from the market point of view. Though the defect has occasionally been observed in white cheeses, it has recently been much more frequently observed in coloured cheeses.

In a previous communication[1] the writer showed that this discoloration was due, not to bacteria nor enzymes, but to lead contamination and the effect of the introduction of various lead compounds during the process of manufacture, and the sources of contamination in cheesemaking were described.

It was shown in the previous article that a common source of infection is the cheese vat itself, and that the red lead paint used by the manufacturers to coat the walls of the inner jacket was the infective agent. Contamination by lead from this source could be entirely obviated if utensil makers employed some other protective coating than red lead on the jacket surfaces. The structure of such a paint film—which employs only linseed oil

[1] Black Spot in Cheese, *Scottish Journal of Agriculture*, vol x, No. 2.

as the vehicle—is too permeable to water, and is therefore liable to be easily detached by the alternate action of steam and water.

A reasonably good protective coating—which has a non-lead basis—may be produced by the application of a good water-resistant varnish pigmented with flaked aluminium powder. The aluminium paint should be applied to the perfectly clean metal surface and stoved to harden the film, or alternatively allowed to dry for three days.

An even better surface protection is afforded by a bitumastic paint with a celluloid basis, the paint film produced by which is heat and water resistant and is elastic. We strongly recommend this composition to dairy utensil manufacturers.

Recently, a number of cases of black discoloration in farm-made cheeses have been reported to our Laboratory. The discoloration was mostly of the diffuse type, though, on close examination, innumerable black specks could also be detected. Samples of the discoloured cheeses, when submitted to the micro-chemical test, revealed the presence of lead in every case. Three of the farms where these cheeses were made were visited at the end of the cheese-making season, when, as is the custom, the vats are dismantled for winter storage. In none of these cases could any flaw or perforation be detected in the inner casing, and consequently the possibility of lead contamination from this source had to be ruled out. The only suggestive feature was that at each of these cheese-making farms the same brand of commercial annatto was used. This particular annatto was issued in metal containers.

A drum, containing some of the annatto actually used in the manufacture of cheese which subsequently showed black discoloration, was obtained from a dairyman in Dumfriesshire. A portion of this annatto was used in the making of a small cheddar cheese; a control cheese was simultaneously made with a standard brand of annatto (Hansen's), milk of the same origin being employed in each case. After a ripening period of ten weeks both cheeses were cut and examined. The control cheese was perfect in colour, while the experimental cheese (in which the " suspect " annatto was incorporated) showed typical black discoloration. The annatto was therefore the vehicle by which the lead factor was conveyed.

Chemical examination of the annatto confirmed this conclusion. The ordinary chemical test applied to the annatto in question gave positive results; the micro-chemical test was also clearly positive. Negative results were obtained with the standard annatto.

A sample of each annatto was evaporated to dryness and calcined. The ash of the standard annatto was greyish white in appearance and showed no trace of colour, nor did it give any lead reaction. The ash of the other annatto contained a bright red substance which dissolved in hot dilute hydrochloric acid and gave the typical lead test. Further examination proved that this coloured substance was red lead.

The source of the lead compound in this commercial annatto had still to be determined. As the annatto was sold in metal drums, one might imagine that the lead was derived from solder in the jointings of the container. [Caustic alkali, which is the vehicle in which the colouring matter of annatto (Bixin) is conveyed, has a solvent effect on solder.] The metal drum was therefore sawn through and the interior surfaces examined. No obvious solvent effect in the metal seams could be discovered, and indeed no internal soldering was apparent at all. Even if solder had been the origin of the lead, the compound formed would not be red lead.

The only feasible explanation of the presence of the lead in the annatto is that the primary material from which it had been prepared contained red lead, and that the manufacturer was unaware of this when he purchased his raw material. The sophistication of inferior annatto cubes and annatto paste with coloured compounds was not an uncommon practice in former years. Thus, according to A. W. Blyth (Foods, their Composition and Analyses, 4th edition, 1896), among the adulterants which have been found in annatto are turmeric, red ferruginous earths, venetian red and red lead. Probably then the batch of seed or paste from which the annatto had been prepared had originally an inferior colour, and to impart the bright chocolate red colour which is characteristic of high class annatto seed the exporter had sophisticated it with red lead.

Annatto manufacturers should, therefore, be on their guard when purchasing annatto seed or annatto paste to see that the raw material is pure and unadulterated.

A section of the Food and Drugs Act would render the sale of such lead-contaminated annatto illegal and the vendor liable to prosecution.

The Composition of Swedes.

IN this JOURNAL (Vol. IX (1926), 160; X (1927, 429) an account was given of the work carried out since 1923 by the committee appointed by the Department of Agriculture for Scotland to investigate the chemical composition of swedes; one of the results of this investigation was to show that the yield of dry matter per acre was a figure of much significance, and that further information on the yield of the different varieties under varying conditions of soil and climate was necessary.

Since then further yield trials have been carried out at Edinburgh (Boghall and East Craigs) by Dr. Lauder and at Aberdeen (Craibstone) by Professor Hendrick, the same varieties being used as in the earlier experiments.

One of the results of the earlier work was to show that if the varieties were arranged in the order of their dry matter content, the order was roughly the same at the different centres and for the different years; that is to say one or two varieties

were almost invariably at the top and others with equal certainty at the bottom of the list; the position of the remainder was somewhat less certain, and varied from place to place and from season to season. The results of the more recent work confirm these earlier findings, and the average results for the years 1926, 1927 and 1928 at Aberdeen and Edinburgh are given below :—

Average percentage of Dry Matter at the three centres (Boghall, East Craigs and Craibstone), 1926-27-28.

Group I.	Kinaldie	12·52 per cent.
,, II.	Bangholm ... ... Stirling Castle ... ... Aberdeenshire Prize ...	11·85 ,,
,, III.	Best of All ... ... Magnum Bonum ... ... Caledonian ... ... X'L All ... ... Bronze Tankard	11·41 ,,
,, IV.	Picton	10·70 ,,

As before Kinaldie contains the highest percentage of dry matter and Picton the lowest, the difference being quite considerable, viz. 1·82. It will be seen that the general order of the varieties is very similar to that found in the earlier experiments.

The difference in the percentage of dry matter in roots grown at the College Experimental Farm at Boghall and at the Plant Registration Station of the Department of Agriculture for Scotland have already been referred to, the seed being the same in both cases; both centres are about the same distance from Edinburgh, but Boghall is at an elevation of 600-800 feet, while East Craigs is only about 200 feet above sea level; the earlier experiments showed that the percentage was always higher at Boghall and the recent work confirms this; for example Kinaldie contains 13·91 per cent. at Boghall and 12·22 per cent. at East Craigs, while the corresponding figures for Picton are 11·37 and 10·43; the average of all the varieties is 12·66 at Boghall and 11·31 at East Craigs. On the other hand the yield per acre is considerably higher at East Craigs.

Yield of Dry Matter per acre.—The yield of roots per acre is difficult to determine especially when working with small plots, even when the plots are repeated several times. No regularities have been observed between the varieties which appear to vary erratically, nor could any connection be seen between the percentage of dry matter and the yield per acre. This is possibly due to the number of observations being too small to enable any regularities to become apparent. The variation is less at Boghall than at East Craigs; in 1926 at Boghall, for example, five out of the ten varieties tested gave practically the same yield of dry matter per acre, viz. 2·23 tons; two gave 2·42; and the

remaining three gave 2·05 tons dry matter per acre. The average yield of dry matter for all the varieties was as follows:—Boghall (1926) 2·21; (1927) 2·31; East Craigs (1926) 3·24; (1928) 2·96.

Farm Wages in Scotland.

THE Department have as usual issued with their Monthly Reports for 1st January and 1st July supplements giving the wages of various classes of workers at Martinmas 1928 and Whitsunday 1929. This article summarises these statements, and gives a comparison with the wages current at Whitsunday 1928; a similar article appeared in the issue of the JOURNAL for July 1928.

The money values of the allowances given in addition to the cash wage, as reckoned at each of the three terms mentioned above, are as follows:—

	Whitsunday, 1928.	Martinmas, 1929.	Whitsunday, 1929.
Meal, per cwt.	24*s*.	18*s*.	18*s*.
Milk, per gallon	1*s*	1*s*.	1*s*
Potatoes, per ton	£4, 10*s*	£2, 10*s*.	£2, 10*s*
House, per annum	£6	£6	£6
Coal, per ton	£1, 15*s*.	£1, 15*s*.	£1, 15*s*
Board and lodging for single men, per week	14*s*.	14*s*.	14*s*
Bothy accommodation, with attendance, per annum	£9	£9	£9
Bothy accommodation, without attendance, per annum	£6	£6	£6
Keep of cows and followers, per cow, per annum	£12	£12	£12

The fall in the estimated value of a hundredweight of oatmeal would mean, for men getting 65 stone per annum, about 1*s*. per week, while that in the value of potatoes would mean, for men getting a ton a year, about 9*d*. per week. The other items show no change throughout the period.

The arithmetical averages of the Department's figures for the wages of married men are as follows:—

Average Weekly Earnings of Married Men.

	SUMMER, 1928.						WINTER, 1928-29.						SUMMER, 1929					
	Cash.		Allowances.		Total.		Cash.		Allowances.		Total		Cash.		Allowances.		Total	
	s	*d*.	*s*.	*d*.	*s*	*d*.	*s*.	*d*	*s*.	*d*	*s*.	*d*.	*s*.	*d*.	*s*.	*d*.	*s*	*d*
Ploughmen	29	1	8	9	37	10	29	7	7	7	37	2	29	6	7	9	37	3
Cattlemen	30	9	9	1	39	10	30	10	7	10	38	8	30	7	8	3	38	10
Shepherds	28	9	11	8	40	5	28	9	10	6	39	3	28	5	10	3	38	8

These averages show a slight fall in ploughmen's wages during the past year, the cash wage having risen by 5*d*., while

the value of the allowances is less by 1*s*. Cattlemen's wages show a fall of 1*s*., which is accounted for to the extent of 10*d*. by allowances, the cash wage being less by 2*d*. Shepherds' wages show a larger change, the allowances having fallen in value by 1*s*. 5*d*., while the cash wage is less by 4*d*.

The following table gives in round figures the weekly earnings of ordinary married ploughmen in summer 1928 and in summer 1929 in 38 out of the total number of 52 counties and parts of counties included in the Department's statement.

COUNTY OR DISTRICT.	SUMMER, 1928.			SUMMER, 1929.		
	Cash.	Allowances.	Total.	Cash.	Allowances.	Total.
	s.	*s.*	*s.*	*s.*	*s.*	*s.*
Wigtown	24	16	40	24	14	38
Kirkcudbright	33	5	38	34	4½	38½
Dumfries	33	5½	38½	33	4½	37½
Selkirk	30	6	36	30	6	36
Roxburgh	30	6	36	30	6	36
Berwick	34	6	40	34	4	38
Peebles	34	6	40	34	6	40
East Lothian	34	8	42	34	8	42
Midlothian	34	7½	41½	34	7½	41½
West Lothian	34	7½	41½	34	7½	41½
Stirling	40	3	43	40	3	43
Dumbarton (Lower Clyde Valley)	39	4	43	39	3½	42½
Lanark (N.W.) (Lower Clyde Valley)	36	4½	40½	36	3½	39½
Renfrew (Lower Clyde Valley)	38	4	42	36	3½	39½
Ayr (N.)	36	5	41	35	4	39
Ayr (S.)	35	4½	39½	35	4	39
Lanark (S.E.)	35	4½	39½	36	3½	39½
Clackmannan	38	1	39	38	½	38½
Fife (S.W.)	38	1	39	38	½	38½
Fife (N.E.)	28	13	41	28	10½	38½
Kinross	28½	12	40½	28½	10	38½
Perth (S.E.)	29	11	40	29	11	40
Perth (Central)	28	11	39	28	9½	37½
Angus (S.W.)	31	11½	42½	30	9½	39½
Angus (N.E.)	28½	11	39½	27½	9½	37
Kincardine	28	12	40	29	10½	39½
Aberdeen (E.)	24½	12½	37	24½	10½	35
Aberdeen (N.E.)	23½	12	35½	24	10½	34½
Aberdeen (Central)	23	11	34	23	9½	32½
Aberdeen (S.W.)	25	12	37	24½	10	34½
Aberdeen (N.W.)	24	11½	35½	24	10	34
Banff (N.E.)	25	11½	36½	25	10	35
Moray	25½	10½	36	25½	9	34½
Nairn	21½	13½	35	22½	12	34½
Inverness (E.)	21½	13½	35	22½	12	34½
Ross and Cromarty (E.)	23½	13½	37	24	11½	35½
Sutherland	18	14	32	18½	12	30½
Caithness	16½	16	32½	16½	14	30½
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Average	29 8	8 11	38 7	29 8	7 10	37 6

The arithmetical average of the cash wages for these 38 counties or parts of counties is the same as last year, while the value placed on the allowances is less by 1*s*. 1*d*.

Most of the districts show no change in the cash wage, but an increase of 1*s*. is recorded in Kirkcudbright, South-East Lanark, Kincardine, Nairn and Inverness, and one of 6*d*. in North-East Aberdeen, Ross and Cromarty, and Sutherland,

while a decrease of 2*s*. has taken place in Renfrew, one of 1*s*. in North Ayr and Angus, and one of 6*d*. in South-West Aberdeen.

The range of the total wages, including cash and allowances, in the various divisions of the country is as follows—in the southern counties from 37*s*. 6*d*. to 38*s*.; in the south-eastern counties from 36*s*. to 42*s*.; in the Lower Clyde Valley from 39*s*. 6*d*. to 42*s*. 6*d*.; in the rest of the central area from 37*s*. to 43*s*.; and in the north-eastern and northern counties from 30*s*. 6*d*. to 35*s*. 6*d*.

Single ploughmen.—The average wage of single ploughmen in the south-eastern counties is 33*s*., the same as last year. Most of the south-western districts show no change, but in the Lower Clyde Valley and North Ayr the cash wage averages 18*s*. 9*d*., as compared with 19*s*. 8*d*. a year ago, with board and lodging valued at 14*s*. In Angus, Perth and Fife the average cash wage is 28*s*. 8*d*., or 4*d*. less than last year, while the allowances, valued at 6*s*. 4*d*., show a decrease of 1*s*. In the north-eastern and northern counties there is little change. In Scotland as a whole a single ploughman's wage averages 32*s*. 9*d*. (cash 22*s*. 6*d*., allowances 10*s*. 3*d*.), showing a reduction of 3*d*. on the year.

Women Workers.—Dairy workers receive cash wages ranging from 12*s*. 6*d*. in Bute to 19*s*. in South Ayr, with board and lodging valued at 14*s*., while in the Lothians a cash wage of 25*s*. is paid, with no allowances. Other women's rates vary from 9*s*. in Orkney to 15*s*. in Aberdeen and Lanark, with board and lodging valued at 14*s*.; where the whole is paid in cash the wages run from 21*s*. to 26*s*. Women paid by the day generally get 3*s*. 6*d*. or 4*s*.; in Angus 4*s*. 6*d*. is the rate.

Boys.—Where board and lodging are provided the estimated total wage ranges from 21*s*. to 27*s*. 6*d*., according to age and experience. In a few districts where the whole is paid in cash the rates are from 19*s*. to 21*s*.

Girls.—In the south-eastern counties, where girls are paid in cash, the rates vary from 15*s*. to 18*s*. Where board and lodging are provided, the estimated total earnings are considerably higher in some cases.

Casual Workers.—Men get from 5*s*. to 6*s*. and in special cases 7*s*. 6*d*. or 8*s*. a day; the weekly rate varies from 30*s*. to 40*s*., and the usual rate per hour is 9*d*. Women get 3*s*. 6*d*. to 4*s*. a day, or 6*d*. per hour.

Agriculture in Aberdeenshire in the Eighteenth Century.

THE present appearance of Aberdeenshire differs vastly from what it was in the eighteenth century. To-day from almost any eminence in the eastern part of the county the eye can feast itself on a scene which in many respects is unique in Great Britain. In every direction lie unbroken stretches of agricultural land. Only the sites of the farm buildings and roads, the stackyards and the waterways seem to be free from invasion by the plough. Probably in no part of Great Britain

is the proportion of arable land to the total area so high as in the Deer, Ellon and Turriff districts of Aberdeenshire. In their zeal for subjecting land to the plough our forefathers grudged even space for the trees that would have done so much to beautify and shelter the countryside. The whole county has to-day, in spite of the alleged hard times, a singularly prosperous air. The well-tilled, well-laid out, well-fenced rectangular fields please the eye no less than do the neat, substantial and prosperous farm houses and steadings. In these Aberdeenshire steadings there is nothing shoddy, nothing tumbledown, and one compares them very favourably with the ramshackle farm buildings so frequently seen in the south of England and on the continent.

Apart, however, from the somewhat bleak and treeless aspect of parts of Aberdeenshire, the appearance of the county to-day differs vastly from what it was nearly two hundred years ago. Instead of neat and well-cultivated fields one saw little but bogs and moorland broken here and there by little patches of cultivation, which on closer inspection proved to be the high backed rigs on which crops of a kind were grown. All the more fertile land was then a swamp. Cultivation was confined to the steeper and drier lands. No enclosures were to be seen except for the rude turf walls that surrounded the folds, into which the cattle were driven at night. The houses were hovels which had been hastily erected and which could be as hastily demolished. Kind neighbours in a fit of industry could provide a young couple with a "house fit to live in" in the short space of a day. If the houses were poor, mean hovels without chimneys, without proper windows and without even proper thatching, the appearance of the outhouses was worse still. Moreover only the better-off farmers could boast of two-roomed houses in the early part of the century. In some of the poorer class houses the cattle occupied one part of the one and only room and the family the remainder. Amongst such surroundings dirt and disorder reigned supreme. Poor and often insufficient food combined with bad cooking and dirty surroundings gave to everyone a listless and indolent appearance. Except in harvest time hard work was unknown, and even then the people were possessed by only short fits of industry. At other times of the year the men, instead of casting their jackets to the work, put on more clothes to do such outside work as ploughing. Usually they were to be seen hanging about the houses in listless groups seeking the smallest excuse to get away from home. Communions in those days were attended often by thousands of people from neighbouring parishes and lasted for days on end. Fairs, baptisms, penny weddings and funerals were all celebrated in great style. Agriculture, however, was in a shocking condition. The farm lands were divided into infield and outfield. The infield portion nearest the houses was, by virtue of its receiving all the farmyard manure, continually cropped, the rotations consisting of oats, oats, bere, and then oats again. The outfield, about six times as large as the infield, was frequently divided into two portions, the fold and the faugh.

The fold portion got its name from the fact that on a part of this land—usually about a tenth part—the cattle were folded for the night. The walls of the fold were made of cast turf and every year the site of the fold was shifted. The vacated fold was usually cropped with oats, and cropping took place year after year until the returns were so poor that it was no longer profitable to crop. Thereafter the land remained vacant until it was folded again. The faugh portion of the outfield received somewhat similar treatment to the fold, except that it received no manure whatsoever. About a tenth portion was broken up every year and cropped until it could be cropped no longer. The breaking-up process was usually preceded by rib ploughing in the early summer and later on by the burning of the sods. The term "burnt" or "brunt" land still persists in such place names as "Farburnthead" in the parish of Fintray. Ploughs in those days were ludicrous affairs. They were ponderous wooden articles, drawn by lumbering teams of oxen and horses, or by oxen alone. Often there were eight or ten oxen, four abreast. One man held the plough, another led the team walking backwards, a third man, termed a goadman or gadman, exercised the function of driving the oxen either by humouring them by his skill in whistling or by applying his sharp stick to their bodies. The ground was so rough that it had to be levelled down. The clods were broken by hammering. The harrows were made entirely of wood. When the Barclay of Ury of that time took to Stonehaven a Norfolk ploughman who could single-handed hold the plough and drive the two horses yoked to it, there was great talk and wonderment. The roads were so bad that wheeled vehicles could not be used. The same Barclay also introduced to the north the heavy ponderous English waggon, and the passage of the vehicle along some of the Aberdeen streets caused fear and trembling amongst the people, for the houses shook with the vibration.

The winter food for horses and cattle was then straw or boiled chaff. Turnips were unknown until Barclay introduced them from England. At the end of the winter the cattle were often too weak to stand and had to be carried out to the pasture. Potatoes at the beginning of the century were practically unknown. The wild or grey oat, now practically unknown save as a weed, was then called the "sma" corn. Threshing mills in the first half of the century were unknown. The corn crops were threshed by the flail and fanned by the winds of heaven. Mechanical fanners which were then being introduced were regarded as inventions of the devil. Rye grasses and clovers, though in use in England at that time, were unknown in Scotland. When the fold or faugh land became too poor to crop, it was allowed to clothe itself with a pasture of weeds, moss and thistles. Such a pasture was deemed sufficient to restore the land to fertility, as instanced in the following "saw":—

"If land be three years oot and three years in
T'will keep in good heart till the deil grow thin!"

Custom, based largely on ignorance and superstition, did much to hinder agriculture. Many farmers fixed the 10th day of March as the earliest date on which ploughing could be commenced. The grain crops could be safely sown after the ash trees' leaves were out, i.e. in the month of June. Under such conditions yields were very low, and were considered satisfactory if three or four times the seed was produced. In late seasons the grain crops did not even ripen. A succession of cold and sunless summers in the opening years of the century created widespread disaster. Thousands of people died and were placed in graves without either coffins or winding sheets.

As the century advanced, however, considerable progress was made in the art of agriculture. Land was enclosed and drained. Pioneers like Barclay of Ury, Grant of Monymusk, Anderson of Monkshill, Cumming of Achry, and Silver of Netherley introduced better methods. Lime began to be used as a manure. Turnips and potatoes were gradually introduced. The art of stall feeding of cattle was initiated. Suitable rotations of crops were practised and more attention was paid to the breeding of all kinds of live stock. The landlords of that time were in large measure responsible for these improvements. The more enlightened of them granted improving leases at nominal rents to enterprising tenants. Educated men vied with each other in their knowledge of agriculture. The minute book of "The Farming Club at Gordon's Mill," now in King's College library, Aberdeen, tells us how some of the more active and prominent members of that club were professors at King's College. The object of the club was to improve agriculture. Information regarding the practice of agriculture in other districts, chiefly Norfolk and the Lothians, was gleaned either by letter or by observation of individual members. The drawbacks to improvement in agriculture were eagerly discussed, and arrangements were made whereby trials of newer and improved systems could be carried out.

Aberdeenshire to-day owes much to those pioneers of the latter part of the eighteenth century. A soil which was naturally unpromising was made fertile through colossal and untiring efforts. Round Aberdeen itself the soil was almost literally made by the hand of man. "The twal mile roun aboot" is no chance meaningless allusion. The enthusiasm created by such societies as the one at Gordon's Mill is to-day reflected by the important place which agriculture occupies in the elementary school and university alike, by the numerous and flourishing agricultural societies which exist all over the county, by the widespread publicity which agricultural subjects enjoy, and by the extraordinary fame which the sons of this county have acquired in agricultural realms.

THE following article has been contributed by Mr. James Dunlop.

Potato Growing in Holland.

System of Preserving Potatoes.—Few crops provide a greater supply of human food per acre than potatoes, and they constitute a considerable part of the farm economy and food supply of most countries of the world. The British farmer learned from the Dutch the art of potato growing as well as of green cropping generally about 200 years ago, and Holland is the country where potatoes are still grown to the greatest perfection. In that small country, one half of which has been reclaimed from the sea and the other part largely from heather and bog, potatoes are cultivated for two distinct and separate purposes, viz. for human consumption and for manufacturing.

The Factory Potato.—On the reclaimed bog land, on which the unemployed of Holland have been engaged in remunerative work, potatoes are grown for manufacturing purposes only, such as the making of potato meal and the extraction of starchy foods, macaroni, spaghetti and chocolate. For this purpose the Dutch farmer aims at quantity, not quality. The small Dutch farmers, who are the heaviest users of artificial manure in the world, grow from 20 to 26 tons per acre—without dung—of the coarse variety, called "Thorbechi." The farmers run their potato factories on co-operative principles, and get about 35*s*. per ton for potatoes of this variety.

Eating Potatoes.—In Holland eating potatoes are grown in the coast districts of Friesland, North Holland and Zeeland. As a rule the farms are small and the acreage of potatoes is confined to 4 or 5 acres per farm. The value of potato land is high, amounting to about £250 per acre. The upkeep of the sea walls involves considerable expense and taxation is heavy, being from 10*s*. to £1 per acre. The cost of labour is similar to that in Scotland, and varies from 30*s*. to 40*s*. plus perquisites per week.

That the Dutch at certain seasons can and do invade the British market is not easily understood, as their natural advantages are not apparent. Particularly well educated for his job—10,000 young Dutch farmers attend the winter agricultural schools annually—the Dutch farmer is a scientist and expert in the art of manuring and of cultivation and grows large crops. His co-operative manure factories provide him with cheap manure, and his co-operative selling agency, which delivers anything from a 20 lb. bag to a boat load of potatoes, secures for him all the middleman's profit. In this he scores over the home farmer, whose potatoes often pass through the hands of a number of middlemen, with the result that the price is doubled when they reach the consumer. One of the favourite eating early potatoes in Holland is the Great Scot. Somewhat yellow in texture in Holland, it is a fairly dry potato with a fine flavour and is a large cropper.

A feature of the potato field in North Holland in the month of June is the strength and regularity of the rows of plants. This regularity is secured by a revolving marker on the single horse plough. The potatoes are planted every second furrow on prepared soil.

Preserving Potatoes.—Unlike grain, potatoes in a year of plenty cannot be kept for use in the following year. Their keeping properties are generally exhausted before the new main crop is ready. In districts remote from the co-operative potato meal mills the Dutch farmer practises a system of preserving his surplus eating potatoes for stock feeding.

This system is valuable (1) where potatoes before digging have been attacked by disease and the keeping properties of the refuse so impaired that instant consumption or preservation is necessary, or (2) in seasons when crops have been exceptionally abundant and prices are correspondingly low, and the potatoes cannot all be consumed even by stock without considerable loss before they decay, as might be the case this season in Scotland. It is then before they are badly sprouted that the system of preserving potatoes in Holland is practised and proves profitable.

The Dutch Method.—The following method of preserving potatoes practised in Holland enables them to be kept wholesome for an indefinite period. A portable washer and steamer is used to wash and steam the potatoes, which are then pressed firmly into a pit in the ground so as to exclude air and covered over with a layer of earth. Two men with two steam boilers capable of holding 250 to 300 lbs. each can cook about 12 tons of potatoes per day. For this purpose about 1½ cwt. of charcoal are required. The total cost of labour and fuel works out at about 2*s*. per ton.

It is essential to steam the potatoes in as little water as possible and to pour off the water before they are packed in the pit. The pit is about three feet deep and of a similar width. It is imperative that the potatoes be firmly pressed and packed to exclude air. Unless this is carefully done, loss follows.

Old thin jute bags are put over the potatoes and a layer of earth about a foot or so deep is placed on the top. In a wet climate the pit is thatched over with straw and care taken to divert the water from the potatoes. If the usual quantity of salt is not added when the potatoes are steamed, it should be added before the potatoes are used.

The feeding value and flavour of the potatoes are but little affected by this process and they will keep in the pit for years. Authorities say that the loss in the feeding value of the potato resulting from this process is less than 5 per cent. One ton of steam potatoes is regarded as equal in feeding value to 5 cwts. of maize meal.

The following article is contributed by Mr. John Anderson, B.Sc., N.D.D., of the West of Scotland Agricultural College.

Failure of Cultivated Varieties of Oats to grow.

There are certain areas in Orkney, the Western Isles, and various districts on the mainland of Scotland where cultivated varieties of oats will not grow, but where the "small oat" (*Avena Strigosa*), myrtle oat, bere and rye can be grown with much success. References to this fact have been made by different authors in articles which have appeared in this JOURNAL,[1] and there appears to be general agreement that the failure of cultivated oats in these areas is attributable to the over-alkalinity of the soil resulting from overdressing with seaweed, whereas this soil condition is more favourable to the growth of *Avena Strigosa*.

In a recent article on "Oat-sick Land in relation to Eelworm Disease,"[2] Dr. Robertson summarises the results of his experiments and observations as follows :—

1. The failure in the growth of oats on oat-sick soil is due to adverse soil conditions and improper nutrition, probably resulting from manuring the soil with cockle shells or fisher dung.
2. The belief that eelworms are mostly present in oat-sick soils and are the cause of the failure of the oats is incorrect.
3. Oats develop normally and produce a profitable crop on oat-sick land if nitrogen is applied at seeding in such a form that it is fixed by the soil, e.g. sulphate of ammonia.

The writer has been interested in this problem for a number of years, and the results of his investigations may prove of some interest and contribute to its solution. His attention was first drawn to it in 1907 by the late Mr. Robert Morris, V.S., Reiss Lodge, Caithness, who showed him a field on his farm where white oats failed to grow, but on which a black oat obtained from Orkney grew successfully. He mentioned other farms in Caithness where the same conditions prevailed. Mr. Morris gave two possible explanations. The first was that in the days when the farm was part of a crofting township the surface of this field was "skinned" to provide turf for the "fail" dykes which were built by the crofters. The second was that it might be due to an excess application of shell sand which was carted from Reiss sands and spread over the field.

In 1910 during a course of agricultural lectures in the Island of Tiree the writer was frequently asked to give his opinion regarding the value of seaweed as a manure, particularly as applied to the potato crop. At that time he had no experience in the use of seaweed and gave the general reply that it supplied the

[1] "Agriculture in the Outer Hebrides," Colin M'Donald, *Scot. Jour. of Agric.*, vol ii, No. 4; "Agriculture in Shetland," J. W. M'Gillvray, *Scot. Jour. of Agric.*, vol. iii, No. 4; "Agriculture in the Outer Islands of Argyllshire," W. W. Philip, *Scot. Jour. of Agric.*, vol iii, No. 2; "Glimpses of Old Time Scottish Farming," Prof. J. A. S. Watson, *Scot. Jour. of Agric.*, vol. xi, No. 2.

[2] *Scot. Jour. of Agric*, vol. xii, No. 1

same ingredients as farmyard manure, but was poorer in phosphoric acid and contained more potash. In 1911 experiments were carried out at several centres with the potato crop. Six plots were laid down with seaweed, farmyard manure, and half and half seaweed and farmyard manure, used alone and in combination with a complete mixture of artificial manures. It was found that seaweed alone gave as heavy a yield as farmyard manure, but that the quality of the tubers was distinctly inferior. When artificials were used in addition the yield, quality and flavour of the potatoes from the seaweed were better than when farmyard manure was used. After several trials a mixture of 1 cwt. sulphate of ammonia, 5 cwt. superphosphate, and 1 cwt. sulphate of potash was found to give a good return both in yield and quality. As far as the potato crop is concerned it would be foolish to neglect the use of seaweed, which can be got for the carting away.

The effect of seaweed on the oat-crop was also tested. The writer was surprised to find that *Avena Strigosa* was the principal oat grown in Tiree, and he was inclined to be sceptical when told that cultivated varieties would not grow. He arranged for the varieties Sandy, Potato, Mounted Police, Beseler's Prolific, Yielder and Black Tartarian to be sown, and in order to ensure success a complete and liberal manuring was given. The oats brairded, grew luxuriantly and gave every promise of success, but when they should have been shooting into ear, growth ceased and the leaf blades took on a reddish brown appearance. The following year several other varieties were tried and manured, but with the same result.

In 1915 a demonstration area was formed in Tiree by arrangement with Mr. Malcolm M'Lean, Kirkapol, who placed his farm almost unreservedly at the disposal of the Agricultural College for demonstration purposes. No definite rotation had previously been followed, a practice which still exists in the greater part of the island. The farm was in the first place divided into fields of three acres each. Potatoes and turnips were grown with the aid of seaweed and artificials, and good crops were generally obtained, but the turnips were frequently attacked by the cabbage root-fly. In 1915 the lea oats were grown in very sandy soil where Mr. M'Lean would by choice have grown rye. It was decided, however, to grow a mixture of Sandy Oats and *Avena Strigosa*. The summer of 1915 was scorchingly hot and the return from this crop was disappointing, for only the *Avena Strigosa* reached maturity. In the following years no attempt was made to grow a cultivated variety of oats as the principal crop, only a small plot of less than one quarter acre being sown with potato oats to measure any improvement in the condition of the soil. The potato oats were well manured, yet each year the plants grew well only until the ear should be formed, when growth stopped and the rusty colour appeared.

It was then assumed that deficiency of nitrogen, phosphoric acid and potash was not the cause of the failure, but it was

thought that the failure might be due to a deficiency of humus. It was therefore decided to adopt every means of increasing humus. This could be done only by judicious cropping and manuring. The method practised in the rotation was as follows :—

1st Year.—Lea Oats (*Avena Strigosa*).—Seaweed applied on the lighter parts of the soil.

2nd Year.—Potatoes and Turnips.—Seaweed was relied upon mostly, but when dung was available some was put in the drills for turnips. The seaweed was spread on the surface as collected and ploughed in.

3rd Year.—Barley (bere), as the nurse crop for grass seeds. An application of seaweed was given if it came ashore, and if not, rye was grown on the more sandy parts. A good mixture of grasses and clovers, including wild white clover, was sown.

4th Year.—The young grass was top dressed with farmyard manure and, as a rule, all this manure was put on the grass. Seaweed was not applied to the young grass as experience showed that it "burnt" it up.

5th Year.—The second year's grass was top dressed with seaweed and either cut for hay or grazed according to the need for wintering fodder. Seaweed is a valuable manure for second year's grass and older grass, and it has also a great effect on the growth of clover.

6th Year.—The third year's grass also received seaweed when it could be obtained. The grass was grazed by cattle and sheep, and in the last year the stock were kept on it as much as possible so that their droppings might increase the fertility and the humus.

It will thus be seen that no attempt was made to reduce the amount of seaweed, but on the contrary it was used as much as possible.

After being cropped according to this scheme since 1915 with a plot of about one quarter acre of potato oats in the lea, it was found that in 1925 the potato oats came into ear and ripened. In 1927 Mr. M'Lean wrote as follows :—"I am pleased to inform you that the crop of potato oats is quite a success." This crop was sown in the same field on which the mixture of Sandy Oats and *Avena Strigosa* was such a disappointing failure in 1915.

There can be no doubt whatever that deficiency of humus is the chief factor causing the failure of the oats to grow. It explains the failure in Tiree and also in Caithness. It is not quite correct to say that the cause of the failure was removed in Caithness when the practice of applying seaweed was abandoned. Failure of oats may still be seen any year in Caithness on some fields on the roadside between Wick and John O'Groats, and it is almost certain that seaweed was never used on them. On the thin soils overlying the boulder clay of Caithness humus is deficient, and in this type of soil and also on those

of a sandy nature much benefit will be derived from an accumulation of humus. The inclusion of wild white clover in seed mixtures has already brought about great improvement in many soils in Caithness and elsewhere, and this improvement is generally attributed to the nitrogen which has been accumulated, but credit should also be given to the increase of humus.

The record of Aberdeenshire farming between 1758 and 1765[1] is of special interest in connection with this subject. The Norfolk rotation of cropping was introduced into England in 1730. It took several years to break down the prejudices of these days, and it was about 1760 when the new system began to be practised in Aberdeenshire. The improvement which would thus be effected would enable cultivated varieties of oats to be grown, and the use of clover and grasses would tend to conserve the humus.

In Tiree and in Shetland the continuous grain growing with oats, barley or rye, which is still practised, necessitates the annual ploughing of the land. After five years or so the yield becomes so reduced that little more than the seed is returned. Ploughing is then abandoned and the land is left out, generally without grass seeds being sown, until it becomes clothed with whatever grasses, clovers and weeds will grow. After a period of seven years or thereby the land is considered to have recovered some of its fertility and is again put through a course of cropping. The rotation might thus be described as five to seven years of cultivation and five to seven years of rest from cropping. This system is very wasteful of humus.

In 1923 the black oat which was obtained from Orkney by Mr. Morris and other farmers in Caithness was introduced into Tiree, where it grew very well. This oat is the myrtle oat, but to what extent it will supplant *Avena Strigosa* is not certain.

It should be mentioned, however, that *Avena Strigosa* is not a weed. It provides good feeding for stock throughout the winter and is fed usually in the sheaf. Only what is required for seed purposes is threshed. The feeding value of the grain is very high. The late Professor Berry found the average percentage composition of the kernel of thin husked, thick husked, and of *Avena Strigosa* oats to be as follows :—

	Protein.	Oil.	Carbohydrate.	Fibre.	Ash.
Thin Husk ...	13 5	8 20	74·59	1 55	2 16
Thick Husk ...	15 88	6·94	74·13	1 46	2·09
Avena Strigosa ..	17·18	9·39	69·60	1 39	2·44

It will thus be seen that *Avena Strigosa* is not to be despised. It has the further advantage that the grain is not easily shed, a point of considerable importance in these wind-swept islands.

[1] "Farming in Aberdeenshire - Ancient and Modern." James Wilson, M.A., B.Sc., *Transactions Highland and Agricultural Society*, 1902.

The conclusions which may be drawn from these investigations are :—

1. The failure of cultivated varieties of oats to grow is due to a deficiency of humus in the soil. This deficiency may be made good in a few years' time by the adoption of a rotation in which the land is left under grass for at least three years, by the use of all forms of organic manures including seaweed, and by the sowing down of the land with a good seed mixture of grasses and clovers, including wild white clover.

2. Seaweed is a most valuable manure and the return obtained from it justifies its use. It is particularly useful as a top dressing for grassland. It gives a good yield of potatoes, but the quality is improved by the addition of a phosphatic manure such as superphosphate.

3. It has not been proved that the application of seaweed produces alkalinity. On the contrary Dr. Robertson finds a lime requirement in one case of 6 cwt. lime per acre. Decomposition of organic matter should lead to acidity and not to alkalinity.

4. Soils can be found in most counties in Scotland which are deficient in humus. Lime is also required over large areas. Lime and humus are probably the two most outstanding deficiencies in Scottish soils at the present time.

5. The use of the term oat-sick land does not convey a correct impression. If the land had previously grown oats and then failed to do so the use of the term might be justified; but in the soils under review the oats would not grow at all, and it would be more correct to say the land was unsuited for the growth of oats.

Reviews.

Agricultural Progress. The Journal of the Agricultural Education Association.—Vol. VI, the issue of this Journal for 1929, well maintains the high standard of quality and interest of previous numbers.

"Recent Advances in Dairy Science" are dealt with in the opening article by Dr. Norman C. Wright, which summarizes the latest knowledge regarding the feeding of dairy cows, the physiology of milk secretion, the inheritance of milk yield and quality of milk, and the nutritive value of milk.

A similar contribution by Dr. H. G. Sanders brings together the results of work at Cambridge and elsewhere relating to agricultural physiology such as sexual cycles, the life of the sperm, and artificial insemination, fertility and its variations, and milk secretion.

A full report is included of papers read at the summer meeting of the Association at Belfast in 1928 and the winter meeting in London. These embrace such diverse topics as "Agricultural Administration in Ulster" by Dr. J. S. Gordon; "Fattening Pastures of Leicestershire" by Mr. T. Hacking; "Pit Silage" by Mr. R. Mackenzie; "The Ryegrass Seed Industry of Northern

Ireland" by Mr. S. P. Mercer; "Methods of Pasture Analysis" by Dr. R. A. Roberts; "Field Work on the Soils of Kent" by Mr. B. S. Furneaux; "The Importance of Method in Teaching" by Sir A. D. Hall; "The Organisation of Agricultural Research and Teaching in Northern Ireland" by Dr. G. Scott Robertson; "A Philosophy of Agricultural Education" by Mr. A. B. Bruce; and two accounts of the "Poultry Industry in Northern Ireland" by Messrs. Adams and Shaw.

Reference is made to recent activities such as the Imperial Agricultural Research Conference, the Educational Exhibit at the Nottingham Royal Show, the World's Dairy Congress of 1928, the Rothamsted Conferences on malting barley and changes in the old rotation, and the establishment of the Hannah Dairy Research Institute.

Notices of deceased members, a list of recent bulletins and reports, and reviews of agricultural books conclude the volume, one which everyone interested in the development of agriculture ought to peruse.

Beef Production in Great Britain, by Professor T. B. Wood and Mr. L. F. Newman.—This little book is a model of precision and lucidity. It should be in the hands of every cattle feeder in the country. The information which it gives is at once scientific and eminently practical; the illustrations are skilfully devised and beautifully reproduced; and the tables bring together much useful information regarding the changes in composition which occur in the carcases of fattening animals at various ages.

After describing the present practice in beef production and calling attention to its defects, the authors make suggestions for improvement. One is to improve the quality of the product itself, and here Scottish beef comes in for praise. A second is to improve the methods of slaughter and the treatment of the carcases before they are sent to the market. A third suggestion is to organise on more business-like and economic lines the transfer of store cattle from the breeding to the feeding areas. The production of baby beef is also recommended, with better methods of obtaining calves from dairying districts and of providing the concentrated food required.

The latter part of the book deals with the chemical composition of the different cuts of beef from animals specially fed and slaughtered under the supervision of the investigators. The primary joints known as "London cuts" are dealt with in detail, and their average composition shown for animals at all stages from baby beef animals to three year olds.

Minerals in Pastures. J. B. Orr, assisted by Helen Scherbatoff.—One of the main services rendered to Agricultural Science by the Rowett Research Institute in Animal Nutrition has been to emphasise the importance of minerals in the dietary of farm animals; and not merely their presence, but also the amount of each requisite mineral constituent proportional to the others. Applied to the natural dietary of these animals—pasture

grasses, this theory is held to account in great measure for the known differences that exist between pastures, and also for the gradual deterioration of pastures by continual grazing without restorative treatment.

In this treatise Dr. Orr sets forth the whole case for the proper appreciation of the rôle played by minerals in pastures. He stresses the economic importance of the problem from the Imperial standpoint, and shows that it must be studied not only from the points of view of the botanist and soil chemist, but also from those of the biochemist and the physiologist who are interested in the effects of different types of pasture on the nutrition of the grazing animal.

The actual amounts of the various minerals found in different kinds of pastures are given as found by numerous investigators, and the factors affecting this mineral content are studied. Several chapters are devoted to the effects of mineral deficiencies of pastures in various parts of the world, and to the effect on the pathological conditions resulting therefrom of direct administration to the animal of the deficient minerals or the enrichment of the pasture by the application of mineral fertilisers to the soil. Apart from the prevention or cure of diseases, it is shown that these measures may influence the rate of growth of young animals and also the rate of production in adult females.

The conclusion is reached that the information now available " warrants the belief that the carrying capacity of pastures can be much increased and the health and quality of the animals grazing in poor pastures can be much improved. . . . It is probable that the total production of the grazing lands of the world can be doubled."

The book is introduced by a preface in which Major Walter Elliott describes the interest of the Civil Research Committee and the Empire Marketing Board in the work, and also by a foreword from Professor Cathcart, who commends the monograph as " a veritable source book to those interested in grassland problems and a stimulus to further development of this field of research."

Agricultural Exhibition in Stockholm, 1930.

THE 23rd Swedish Agricultural Exhibition, which will be held in Stockholm from the 19th to 24th June 1930, promises to surpass its predecessors in popularity, and as it will be held on this occasion in the capital of Sweden, frequented by people from all parts of the world, its success seems assured.

The aim of the Agricultural Exhibition is to illustrate the resources of the farming industry of Sweden. In addition, it will be regarded as a comprehensive form of propaganda for agricultural interests throughout Sweden, and is intended to give guidance and incentive to progressive measures, which agriculturists from other lands will find of utility. Accordingly, only the very best specimens of animals, products, requisites, machines, &c. will be exhibited.

Accommodation is being prepared for about 1,500 cattle and 2,000 fowls. A large Dairy Show, with dairies in full swing, showing refrigerators, the making of butter, cheese, and other milk products, will be organised. The sections dealing with agricultural machinery, electrical and other technical appliances, and the scientific, statistical and economic resources of farming will be very comprehensive.

A completely equipped model farm, furnished with all modern technical accessories and with pasture paddocks attached, will be on show, along with a stock of domestic animals suitable for such a demonstration.

The programme also comprises a Horticultural Section, of which parts will be devoted to the laying out of a number of model gardens for private residences, small-holdings and allotments (colony gardens).

Fishery and allied industries will form one section, comprising products of fishing, fish preserving, methods of transport and trading, fishing tackle and equipment, pisciculture and the protection of fish. Even the development of fishing through the years will be illustrated, and a scientific section will show the results of research in fishing waters, &c.

As the Art Industry, Handicraft and Domestic Industry Exhibition will be in progress at the same time as the Agricultural Show, the extensive handicraft and domestic industry section of the latter will be combined with the former for the convenience of visitors.

Problems of British Agriculture.

A SERIES of fifteen articles has recently been published in *The Statist* on various problems of British agriculture; the first article appeared on 2nd February and the last on 8th June. The subject is in the first instance dealt with from a statistical point of view, with particular reference to the past, present and future of live stock and its products, which constitute a very large proportion of the output of British farms. Articles 1 to 7 contain a large amount of information, drawn from a variety of official sources, on the changes that have taken place in British agriculture during the last fifty years, the main feature of these changes being the advance of stock production and the relatively small return now received from grain crops. The author expresses the opinion that this change is not merely transient, and in subsequent articles he enlarges on this theme, with a critical survey of the future of the industry in marketing and production; he also discusses the methods which the trend of international economics and politics may possibly force this country to adopt in order to alleviate the present state of depression in the industry.

The author is by no means despondent as to the future, and while admitting that the regeneration of the industry depends to

a great extent on the policies of the three political parties (which he analyses and criticises) he does not stress the point. Articles 8 to 15, which in the main deal with this aspect of the case, are specially worthy of wide publicity as a thought-provoking incentive to all interested in the subject. Lack of space prevents quotation from the articles, and justice cannot be done to them in a short review. Those who are interested in agricultural economics may obtain from the offices of *The Statist* copies of the issues containing them.

Inspection and Certification of Black Currant Bushes, 1929.

THE Department of Agriculture for Scotland inaugurated this season a scheme for the inspection and certification of black currant bushes grown in Scotland and intended for sale. Under the scheme stocks are certified if found to be true to type and apparently free from reversion at the time of the inspection. It is not possible to certify stocks as free from Big Bud, but no certificate will be issued in respect of stocks which bear evidence of substantial attack of this pest, nor for stocks which are found to be obviously unhealthy in other respects or lacking in vigour.

As far as possible stocks will be certified under the names of the four well-known group types of black currant bushes according to the classification adopted by the East Malling Research Station, namely, French, Boskoop Giant, Goliath and Baldwin. Where varietal names are stated by the grower these will be shown in the certificate in brackets after the names of the types, thus—Goliath (Edina).

The fees payable for inspection are on a sliding scale with a minimum of £1 for any number of bushes not exceeding 5,000, rising to £3, 10*s*. for 100,000 bushes plus an additional 10*s*. for every 50,000 or part of 50,000 bushes in excess of 100,000. Copies of the certificates issued may be obtained at a charge of 3*d*. per copy.

At the close of the inspection season a list will be issued giving the names and addresses of growers whose stocks of black currant bushes have been certified under the scheme.

Importation of Raw Cherries (Scotland) Order of 1929.

IN terms of the Importation of Raw Cherries (Scotland) Order of 1929, made by the Department of Agriculture for Scotland, the landing in Scotland after 15th June 1929 of any raw cherries grown in any European country other than France and Italy is prohibited, unless each consignment is accompanied by a certificate of origin visé by a Local Authority in the country of origin, stating the country and place where the cherries were grown.

The Order further provides that the landing in Scotland of

any raw cherries grown in Italy is prohibited after the 30th June 1929, and that raw cherries grown in Italy and landed in Scotland during the period 11th to 30th June 1929, or grown in France and landed in Scotland after 15th June 1929, must be accompanied by a certificate issued by an officer of the Phytopathological Service of the country of origin in the terms specified in the Schedule to the Order.

The Order remains in force until 30th September 1929.

Agricultural Conditions.

THE weather during March was unusually dry and sunny, but in some parts of the country there were severe night frosts, especially during the earlier part of the month. With the weather conditions so favourable, excellent progress was made in most districts in overtaking the arrears of ploughing that had accumulated as a result of the severe frosts during February. A fair amount of sowing was also carried through under favourable conditions, the soil being generally in good order. The greater part of April was generally cold and dry, and night frosts were frequent in many districts. During the last few days of the month there were intermittent falls of snow, with some sleet and hail, particularly in the north-eastern districts and in Skye and Caithness. In practically all districts the weather conditions during April were favourable for farming operations, and in most cases any arrears of work were overtaken. The rain that fell during the last week of the month improved pastures and the braird of cereals in some areas, but speaking generally, the low temperature that prevailed throughout the month checked growth. The weather during May was on the whole favourable for farming operations and in most districts crops and live stock made fair progress, especially during the latter part of the month. The dry, cold weather during the first fortnight of May, together with occasional night frosts, retarded the growth of crops and pastures, and the conditions at this period were more or less unfavourable for hill lambing in some districts. The weather became more genial later, and with a moderate rainfall at the end of the month the conditions were favourable for all classes of crops and stock.

Despite the adverse weather conditions earlier in the year, wheat has made good progress, and at the end of May the crop had a strong and healthy appearance in most districts. In a few areas, however, the crop is patchy and thin in places, and damage by grub and wire-worm has been reported from several districts. According to the estimates furnished by the Department's Crop Reporters, the area under the crop will prove to be somewhat smaller than last year.

Barley germinated well, and is reported to be vigorous and healthy in practically every district. The estimates of acreage indicate that a further and relatively more serious decrease has

taken place as compared with last year; in North and East Perth the diminution is estimated at about 20 per cent., and in South-West and Central Aberdeen from 10 to 15 per cent.

The outstanding feature of the recent reports on the oat crop is the prevalence of grub, and to a lesser extent wire-worm. The damage caused by grub appears to be most extensive in the north-eastern districts, but the south-western districts have also been affected to a certain degree. On the whole, however, the condition of the oat crop is fairly satisfactory. The area under oats is estimated to be greater by about 5 per cent. in South-West Aberdeen and South-West Angus, while in South-East Perth the estimated increase is about 10 per cent.; slight increases are also estimated in North-East Fife and Dumbarton. A decrease in acreage of from 10 to 15 per cent. is however estimated in Central Aberdeen, while in East Aberdeen, South-East Lanark, Harris and Uist decreases of about 5 per cent. are expected.

At the beginning of June beans were reported to be rather backward in a few areas, but the plants are generally reported to be healthy and vigorous. Ryegrass and clover seeds, which were earlier checked by cold and frost, are progressing satisfactorily, the plants being now generally in a healthy condition.

The planting of potatoes was completed in April in a few districts, and the work was practically finished at the end of May. From the estimates of acreage furnished by the Department's Reporters it would appear that the total area under potatoes will prove to be somewhat smaller than last year. The greatest decrease is indicated in South-West Aberdeen, where the area is estimated to be less than in 1928 by 10 per cent. The sowing of swedes and mangolds was completed or practically completed by the beginning of June. The sowing of yellow turnips was, however, much less advanced at that period, and at the end of May sowing had not begun in North and East Perth, Sutherland, Shetland, Inverness, Nairn and Dumbarton. Some resowing of turnips has been necessary in Moray and Banff as the result of frost and attacks from fly; reports of damage by fly have also been received from Kintyre, Bute and Wigtown. The reports received regarding sugar beet indicate a further and considerable diminution in the area sown, as compared with last year, especially in North-East Angus, South-East Perth, Berwick and Ross.

Fruit trees, despite the unfavourable weather conditions earlier in the season, have on the whole done well, and the crop prospects are good in most of the fruit-growing districts. In most of the north-eastern districts small fruits have suffered some damage from frost; in South-West Angus, however, a heavy crop is expected.

Pastures have now practically recovered from the set-back that occurred earlier in the year, and in most districts are in good condition; in some of the higher districts, however, pastures were still somewhat bare at the end of May. Grazing cattle made good progress during May; dairy cows are in good average condition, and in practically every district the milk yield is

Edinburgh and East of Scotland College of Agriculture.

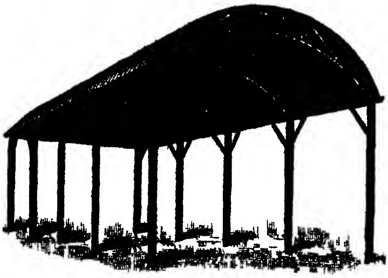
Winter Session,	. .	**October to March.**
Summer Session,	. .	**April to June.**

The Day Classes provide a full course of instruction in Agriculture, Horticulture, and Forestry, and qualify for the Degrees of B.Sc. in Agriculture and in Forestry of the University of Edinburgh, the College Diploma in Agriculture, and the College Certificate in Horticulture.

CALENDAR showing Complete Courses in Agriculture, Forestry, Horticulture, and Allied Sciences in Day and Evening Classes; Short Courses for Farmers and Foresters; Syllabus of County Lectures and Experimental Work, and Scheme of Bursaries for Students resident in the College Area, may be had from the Secretary—

THOMAS BLACKBURN, 13 George Square, EDINBURGH.

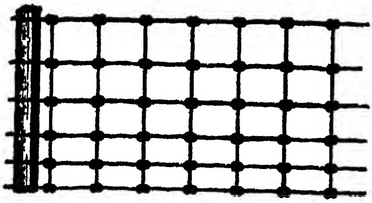
HAY AND GRAIN SHEDS.



Complete catalogue on application.

"RYLOCK" FIELD FENCING

Made in Great Britain.



PERFECTLY GALVANIZED.

Complete descriptive priced catalogue from—

A. & J. MAIN & Coy., Ltd.,
Possilpark, GLASGOW.

THE "SCOTT" SILO

— OF —

Reinforced Concrete

Over 100 SCOTT SILOS in the Country.

Best and cheapest Ensilage Storehouse yet offered.

Requires no maintenance

Proof against fire, storm and vermin

We are Agents for the wonderful **"PAPEC" SILO FILLER.** Low upkeep; efficient worker; will not choke.

Prices from £70 including blow-pipes, distributing pipes and bends; mounted on wheels, built up ready to haul into position; delivered nearest Railway Station; no extras

Full particulars from

JAMES SCOTT & SON
(ABERDEEN), LIMITED,
483-485 Union St., ABERDEEN.

reported to be that of a normal season. Sheep on arable farms have generally thriven well, but the report from Dumfries at the end of May stated that in that area they were much leaner than usual. Hill sheep have made good progress and, despite the severe weather earlier in the year, are now generally in fairly good condition; many deaths are, however, reported to have taken place in South-West Perth. The fall of lambs has been generally satisfactory, and in a few cases the yield has been well over the average. The death-rate has been heavy in North and East Perth and in a few districts there have been losses owing to "wool-ball." In most areas the lambs are now thriving and making good progress. Considerable losses among ewes are reported from Aberdeen, North-East Fife, Berwick, South-East Lanark and Dumfries. In Stirling and Berwick the percentage of eild ewes has been exceptionally high.

The supply of regular and casual labour at the beginning of June was reported to be sufficient for requirements except in Dumbarton and Renfrew, where there was a shortage of experienced women dairy workers, and in South-West Perth, where the supply of skilled labour was rather below the normal.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Pure Lines of Hen Gymro Wheat. *T. J. Jenkins, M.Sc., University College of Wales, Aberystwyth. Leaflet, Series S, No. 1.*—Mr. Jenkins reports on selections made from the well-known Welsh wheat, Hen Gymro, samples of which are obtained from various growers. It was found to contain several distinct morphological types within which were found different physiological types. Plants heterozygous for one or more factors were also found, indicating that in this variety natural crossing is not uncommon.

The original selections were in the course of seven years reduced to five, the continued selections being based on yield, resistance to lodging and quality of grain. Red Standard was the check variety used for comparison. A description of the five selections retained is given, along with detailed accounts of yield and quality of grain and standing power. None of the Hen Gymro selections is as stiff-strawed as Red Standard, and this means that under good soil conditions where stormy weather intervenes before and during the ripening, Hen Gymro is liable to become badly lodged. Under adverse ripening conditions, however, grain development suffers far less, as a rule, in Hen Gymro than in Red Standard, and a combination of relatively poor soil and poor ripening conditions may even cause the grain of some Hen Gymro lines to be actually bigger than that of Red Standard. At Aberystwyth, Red Standard has in most years yielded a very poor grain sample, while the grain of Hen Gymro, though small, has been much better in quality.

Mr. Jenkins makes it clear that Hen Gymro is less suited to land in good wheat growing condition than to land of relatively poor quality. It has the great advantage that it is capable of ripening a good grain sample under very poor ripening conditions.

The Effect of Nitrate of Soda on the Yield and Chemical Composition of a simple Seeds Mixture in the First Harvest Year. *By T. W. Fagan, M.A., W. E. J. Milton, N.D.A., and A. L. Provan, Ph.D., University College*

of Wales, Aberystwyth. Bulletin, Series H, No. 9.—The authors give a complete account of an investigation carried out on a rotation grass mixture in the first year. The mixture used was—16 lb. Italian ryegrass, 2 lb. perennial ryegrass and 4 lb. Montgomery late-flowering red clover, and the systems of management were: (*a*) pasture cut weekly, (*b*) pasture cut monthly, (*c*) hay cut once and aftermath cut twice, and (*d*) successive weekly cuts. Nitrate of soda was applied to half the plots in small dressings at approximately monthly intervals from 31st March to 18th August. The total nitrate of soda was 3¾ cwt. per acre.

The manure increased the yield of grass whether cut weekly or monthly and had a similar effect on the hay and two aftermaths. In the weekly and monthly cuts the manure depressed the phosphoric acid and the lime as well as the phosphoric acid in the hay, but in the second aftermath the influence of the manure on the phosphoric acid and the lime appears to be negligible. The manure extended the growing season, and the response to the manure was greater in the case of the grasses than the clover. The manure had greater influence on the ratio of stem to leaf in the monthly than in the weekly cuts. The yield of dry matter from the same area was much greater under a monthly than under a weekly system of cutting, but the chemical composition of the weekly cut was inferior. The greater yield of the monthly, however, more than counteracted the superiority in composition of the weekly cut.

The volume of milk that might be given by a dairy cow fed with the produce of each plot was calculated on a starch value basis, and a comparison of these values showed that the monthly system of cutting was greatly superior both in control and manured plots and that the manure under both systems of cutting added to the value of the produce, though much more to the monthly than to the weekly cut.

Nationality and Strain Test of Grasses. *By Alun Roberts, Ph.D., B.Sc., and W. A. Jones, N.D.A., N.D.D., Welsh Journal of Agriculture, Volume V,* 1929.—Comparisons were made at the College Farm, Bangor, on different strains and nationalities of certain grasses. Of the species examined perennial rye-grass and cocksfoot show the widest variation of persistency according to nationality and strain. The indigenous types and grazing types have given the best results, and in cocksfoot the nationality of the species proves particularly significant. The different strains and nationalities of timothy and meadow fescue show little variation as components of the herbage for the conditions ruling over the period of the experiment. Danish cocksfoot sown on the control plots was by far the poorest of all the types sown.

Dry Rot of Swedes. *By T. Whitehead, Ph.D., M.Sc., A.R.C.S., and W. A. Pritchard Jones, M.Sc., Welsh Journal of Agriculture, Volume V.* 1929.—The work carried out intermittently at Bangor since 1921, but mainly during 1923 and 1924, is summarised. Among the conclusions reached by the author are the following:—

Evidence is submitted to show that the initial outbreak in a crop is due largely to the introduction of diseased material from the manure into the field, and not to infection from other crops or weeds. Seed infection, if it occurs at all, is of little importance. The disease is spread in the field by means of wind-borne spores. The variety Lord Derby has been shown to be very susceptible. Artificial manures have had little or no effect on the amount of disease present in a crop. Dressing the bulbs on clamping with ground limestone somewhat reduced the development of dry-rot, but not sufficiently to justify its being recommended.

Foderrotfrukternas Foradling (Root Crop Breeding). (*With English Summary.*) *Sveriges Utsadesforenings Tidskrift. Argang* 38, *Haft* 3.—The results of experiments with different breeding methods conducted at Svalof by the late N. Hjalmar Nillson and G. Sundelin are discussed. The results showed a large decrease in dry-matter yield in mangels and an increase in swedes. On the whole, the changes in dry-matter content of the roots go in the opposite direction to that of yield of dry matter. The investigations show that the yielding capacity (of dry matter) of modern Swedish strains is, on the whole, the same as that of those grown twenty years ago. Breeding by methods of mass selection has not resulted in the production of definitely better yielding strains. This, however, did not mean that the breeding work has been of no value. Natural selection operates in the opposite direction to that of the breeders, and the Scandinavian breeders during the last twenty years have been forced to do practically all their work only in order to keep the good strains from sliding back to a lower yielding capacity. The difficulty of the mass selection method

is the impossibility of separating the good and bad genotypes of the populations. While the inbreeding method is the most suitable for separating the different hereditary types out of the mixed populations, the question of loss of vigour is important to the breeder. Investigations at Svalof in beets and mangels show that the danger of loss of vigour in these plants is not so great as to make practical breeding by this method impossible. In swede turnips some unpublished investigations have indicated that the danger of loss of vigour is still less than in mangels.

SOILS.

Studies of Certain Phases of the Inter-Relationship between Soil and Plant: I. Availability of Mineral Plant Nutrients in relation to the Degree of Dispersion. *Walter Thomas, Pennsylvania State College. Soil Science, XXVII,* 249 (1929).—A valuable review is given of the literature on the subject. Most of the evidence indicates that plants take up their mineral nutrients in solution and not in the form of colloids. The author discusses the relation of the composition of the soil solution to the mineral elements taken up by plants, the solubility of silica, the effect of silica gel and the availability of mineral phosphates.

Experiments carried out at the Hamburg-Horn Experimental Station: VI. Root-Solubility of Phosphoric Acid contained in Superphosphate, Neutral Phosphate, Reform Phosphate and Algiers Phosphate. *C. Dreyspring, C. Krügel and R. Pantke. Superphosphate, Vol. II,* 61-69 *and* 81-89 (1929).—The authors describe experiments designed to test the relative solubility of the phosphoric acid in superphosphate, neutral phosphate and reform phosphate, which are artificial products obtained by treating raw phosphate with a small quantity of sulphuric acid, and Algiers mineral phosphate. Approximate quantities of those phosphates were added to sand cultures in which 100 barley grains were grown for 17 days. The plants were then analysed and the quantity of phosphoric acid assimilated by the plants was determined by analyses. It was found that the relative root-solubilities of superphosphate, neutral phosphate (French), neutral phosphate (Czechoslovakian), reform phosphate (Austrian), and Algiers mineral phosphate were approximately 10 : 7 : 5·5 : 2 : 1. It was also shown that the neutral phosphates and reform phosphates after extraction with a 2 per cent. citric acid solution showed practically the same solubility as raw mineral phosphate. This indicates that under the experimental conditions the plants could utilise only the soluble phosphoric acid in the various manures.

Can the Date of Application of Potash Manure Salts influence the Yield of Potatoes? *Diplomlandwert Spüyen—Schneidemühl. Die Ernährung der Pflanze, XXV,* 49 (1929).—It is shown by means of field experiments that the date of application of potash manure salts has a marked effect on the increase in yield of potatoes. The greatest starch content is obtained with a December or January application, and the greatest yield of tubers with a January or February application.

ANIMAL BREEDING.

Cattle.

Factors affecting the Yield and Quality of Milk: I. The Age of the Cow. *R. R. Kay, A. C. M'Candlish.* 1929. *Jour. Agric. Sc., Vol.* 19, *pp.* 342-371.—Using as data 738 pedigreed Ayrshire cows with authentic milk records from the counties of Dumfries, Kirkcudbright and Wigtown, the authors have produced an interesting and instructive paper showing the effect of age on the yield and quality of milk. These 738 cows gave 4,380 recorded lactations. The average Ayrshire appears to produce the greatest quantity of milk and butter fat at seven years of age. The total yield of a heifer is about 85 per cent. of a seven year old cow. As regards total butter fat it is somewhat higher. This accounts for butter fat percentage being highest in heifers, and the authors come to the conclusion that a heifer with a low butter fat percentage is unlikely ever to increase that percentage in a subsequent lactation. The writers are of opinion that the increase in production at maturity is more closely associated with high initial production than with persistency of production.

Some practical points are discussed, and the following extracts may be of interest, especially to Ayrshire breeders :—

"Ayrshire cows in Scotland evidently mature at about seven years of age,

that is at about the same age as the other dairy breeds. As a general rule, therefore, an Ayrshire cow may be expected to be at her best at from seven to eight years of age, though in some cases greatest production may be reached a little earlier or a little later. This fact requires considerable attention. As the average life of a cow in a dairy herd is about four years, it is evident that a very large percentage of the cows are removed from the herd before they reach the age of greatest usefulness. Granted that a considerable number are removed as poor producers, and that a big turnover in the animals within a dairy herd is probably inevitable, yet every possible effort should be made to increase the percentage of animals that remain in the herd until maturity is reached. In this way the average production could be raised appreciably and considerable economies effected."

"It is probably safe to conclude that not only has the dairy cow a considerable period of usefulness after she reaches maturity, but also that there is a tendency to retain good producing cows in the herd even longer than other individuals. This latter practice will be justified owing to the breeding value of the good producers. It will pay to retain them even after they begin to decline in production if they are still capable of breeding."

"The law is not interested in the yield of milk or butter fat produced by dairy cows, but it does pay marked attention to the fat percentage of the milk, as all milk offered for sale for human consumption must contain at least 3 per cent. of butter fat. The fat percentage in the milk of the animals studied here shows on the whole less variation with age than do the yields of milk and butter fat. It is highest in the three-year-old form, drops considerably in the next, remains fairly constant until shortly after maturity is reached, and then shows a downward tendency.

"In the ordinary range of ages, up to eight or nine years, there is therefore little risk of a fall, which may be attributable to age, large enough to bring the fat percentage below the legal limit in the ordinary run of cases. However, when advanced ages are reached the fall may be quite marked, as is seen with the two higher groups. With cows which in their earlier years do not give a very high percentage of butter fat there is a risk that at advanced ages they may give milk near to, or below, the danger point so far as fat percentage is concerned, and in the same way cows normally testing well at an early age might at a greater age give very low testing milk if some other detrimental factor were also at work. The risk of old cows being below the presumptive standard in butter fat should therefore not be neglected."

"If the butter fat production be considered in the same way the results are somewhat the same, though the butter fat yields do not increase as markedly as the milk yields. This is probably due to the fact that less attention has been given to selection on the basis of butter fat yield, or butter fat content, than to selection for milk production. It is undoubtedly true that in the selection which does take place in many herds in the south-west of Scotland more attention is paid to milk yield than to fat yield or fat percentage, though the latter does at times receive some consideration."

A comprehensive review of the literature on this subject is included in the paper. The results have considerable scientific as well as practical interest.

The Use of Purebred Sires in producing Cattle for the Market. *By W. L. Blizzard. 1928. Amer. Soc. Animal Production, pp. 74-77.*—That purebred sires are of importance in live stock breeding has been pointed out in an experiment which was recently conducted at the Oklahoma A. and M. College Experiment Station. The objects of the test were : (1) To determine the cost of maintaining a cow for one year and thus to find the cost of producing a calf. (2) To compare the offspring of the purebred bull when mated with grade cows and scrubs cows. (3) To determine the cost of producing baby beef and to compare the results of feeding the calves, from the various crosses, for a given period.

A herd of 25 cows was maintained during the past few years. These cows were divided into three groups: ten were scrubs mated to scrub bulls; seven were scrubs mated to purebred sires, and eight were high grade cows which were mated to purebred bulls. A close account was kept of all expenses for pasture, feed and service fees. Interest on the money invested in the cows is added to the other costs.

The calves were weaned on November 1, 1927. They were placed in the feed lot on November 16 and given a grain ration until January 12, 1928. On this date they were placed on full feed.

The calves in Lots 2 and 3, where the best results were shown, were sired by a purebred Hereford bull; the calves in Lot 1 were out of the same kind of cow as those in Lot 2.

The initial weights on these calves varied considerably; those in Lot 1, with scrub parents, averaging 472 lbs., those in Lot 2, 540 lbs. The greatest difference was between the produce of a scrub sire and scrub dams as compared to the produce of a purebred sire and scrub dams. At the end of the period, the calves which had purebred blood were almost a hundred pounds heavier than the calves with scrub parents. These good calves showed an average daily gain of 1·85 lbs. and 1·83 lbs. per day, or almost 2 lbs. per day. It took 54 more lbs. of grain to produce 100 lbs. of gain on the calves in Lot 1, which were by scrub sires and out of scrub dams, than it did for the produce of the purebred sires and high grade dams. It also took about 50 lbs. more roughage to produce 100 lbs. gain in Lot 1 than in the other two lots.

The calves were all given the same grain ration and were fed according to appetite. The ration consisted of shelled corn, cottonseed meal and alfalfa hay. Cottonseed hulls were fed for the first 156 days. The calves were maintained on full feed from January 12th to August 4th—205 days.

At the end of the 205-day feeding period, the calves were shipped to the Oklahoma City market and sold. The calves by scrub sires out of scrub dams sold for $12 per cwt. Those in Lot 2, with purebred sires and scrub dams, sold for $14·25, and the calves with purebred sires and high-grade dams sold for $15·50 per cwt.

The calves were measured for difference in height, heart girth, width and length, size of paunch, width and depth of chest, width of quarters and of loin, length and width of head and weight both at the beginning and the close of the experiment.

In studying the measurements at the close of the finishing period, a decided increase was found in the width of the rear quarter during the 205 days. There was a slight increase in Lot 2, where the purebred sire and scrub dam were used, but the striking increase was in Lot 3, where a purebred sire and grade dams were used. This indicates that cattle which have quality show a greater development of high-priced cuts at the finish.

The calves in Lot 3 carried more finish than the calves in Lots 1 and 2. Quality results in higher finish in the latter part of the feeding period. The calves in Lot 1 had a dressing percentage of 57·6 per cent.; those in Lot 2, 60·7 per cent., and those in Lot 3, 61·3 per cent. This is remarkably high when it is considered that average steers dress out from 54 to 57 per cent.

Cost of Beef Cattle Production in U.S.A. *Armour's Monthly Letter*, 1929, *Vol.* 10, *No.* 1.—This is an analysis of the cost of production of beef in the U.S.A. It covers an examination of the production of store cattle on the range, of feeding cattle in the corn belt, and the costs of transit and marketing. Since 1924 there has been a steady increase in the cost of production. In respect of store cattle production, it has risen gradually from 7½ dollars in 1924 to 8¼ dollars per 100 lbs. in 1928 (i.e. from about 33*s*. to 38*s*. 6*d*. per cwt.). The average price of store cattle for that period has fluctuated from 6¼ dollars per 100 lbs. (28*s*. 6*d*. per cwt.) in 1924 to 8 dollars in 1925, and rose steadily from 7 dollars in 1926 till in 1928 it reached 11½ dollars (53*s*.).

The standard net cost per 100 lbs. of finished steer was in 1924 over 8½ dollars (say 40*s*. per cwt.), with a rise of a dollar in 1925 and return to the level in 1926 and 1927, since when it has steadily risen till it now stands at 12 dollars (or 56*s*. per cwt.), and to this falls to be added another 1*s*. 6*d*. per cwt. for freight charges, &c. It is interesting to compare the cost of beef-raising in U.S.A. with the prices in this country.

With better prices for cattle since 1927 the cattle population has increased, and it is expected that with the continuance of prices in their favour the numbers of 1929 will be increased in 1930. To this one might add the significant fact that the U.S.A. is now importing beef from New Zealand and Australia. (See Sir William Haldane's articles in *The Times*, April 8th, 9th and 10th, 1929.)

The Joint Influence of the Period of Lactation and the Age of the Cow on the Yield and Quality of the Milk. *By T. J. Drakeley and M. K. White.* 1928. *Jour. Agric. Sc.*, *Vol.* 18, *pp.* 500-506.—This paper compares the various results previously obtained by the authors and already published and abstracted in these columns. The total number of analyses on which the study is based is 6,566, taken from cows at the London Dairy Show from 1876 to 1925. Tables are given showing the influence of stage of lactation and age of the cow on the yield and quality of the milk for the Dairy Shorthorn, Jersey, Guernsey, Red Poll Ayrshire, Kerry, British Friesian and Lincoln Red Shorthorn breeds. These figures should form a useful piece of reference for those interested, but their practical application, at the moment, is not great.

Studies in Milk Secretion based on the Variations and Yields of Milk and Butter Fat produced at Morning and Evening Milkings. *By S. Bartlett.* 1928. *Jour. Agric. Sc., Vol.* 19, *pp.* 36-47.—The results of the test in the Guernsey and Dairy Shorthorn herds at the National Institute of Dairying at Reading which have been made since 1922 are analysed over a five year period. The samples of milk were taken for three consecutive days at the middle of each month. The intervals between milkings average 8¾ and 15¼ hours respectively, so that the rate of milk secretion is slightly slower during the long interval.

The weight of fat produced at each milking was calculated from the weight of milk and the percentage of fat, then by a similar classification to that used for milk yields, lactation curves were prepared for morning and evening yields of fat during each month of lactation. The yield of fat during a lactation period produces a curve which approximates to a straight line indicating that the rate of decrease in the production of fat is fairly constant throughout the lactation period. On comparing the curves for morning and evening yields it is observed that in early lactation the weights of fat yielded at the morning and evening milkings are practically the same, but as the lactation period progresses the difference between morning and evening yields becomes more and more pronounced, the yield of fat at the morning milking being always greater.

With regard to yield of fat in relation to age, a striking difference is found. First calvers in early lactation produce approximately the same or even a greater weight of fat at the evening milking than they do at the morning milking, and this condition gradually disappears with the advance of lactation. The second calvers produce a little more fat at the morning milking, and in the case of the older cows the morning fat yield is proportionately greater; in all age groups, however, the proportional yield of fat at the morning milking is greater in the later stages of lactation.

The effect of apparent high udder pressure on the lactation curve is noted by the author, who states: "It will be seen that the cows with high udder pressure yielded a lower weight of fat at the morning than at the evening milkings. This question may be viewed from another angle; as a result of some recent unpublished work with the same herd, it may be concluded that the udders of the cows under consideration contain about the same amount of milk and fat just before the evening milking as they do 8¾ hours after the evening milking. It is found, however, that by the usual time of the morning milking the udders contain less fat than the assumed amount about six hours previously. On this basis it seems reasonable to suggest that not only does excessive pressure of milk in the udder cause a decrease in secretion, but also induces reabsorption of part of the milk. This point is not claimed as a discovery, but it is of interest to find apparent reabsorption occurring under ordinary farm conditions. The whole question has an important bearing on work dealing with the effect of age and milking capacity on fat percentage, on problems dealing with thrice daily milking, and on some of the fundamentals of milk secretion. It is hoped to publish some further work on the subject in the near future."

Low proportional yields of milk fat at the morning milkings in early lactation have already been noted. The practical application of this observation would seem to be that if cows are stimulated to secrete more milk, the stimulation should be accompanied by a shortening of the long milking interval in order to obtain the full benefit and to avoid a depression in the fat percentage of the milk.

The percentages of fat from month to month as shown in Table V are remarkably constant throughout the year, and although there is a depression during May this depression is not nearly as pronounced as is usually imagined, the actual fat percentage for May being about 0·15 per cent. below the mean for the complete year.

Since the food of the cow varies considerably during the year, the curve showing seasonal variation provides some information on the effect of foods on fat percentage; and the small differences at various seasons of the year support most of the experimental evidence which has been published showing that foods do not affect the percentage of fat in milk to any appreciable extent, unless those foods upset the health or digestion of the cows.

Variations in Milk Yields caused by Season of the Year, Service, Age and Dry Period, and their Elimination. *H. G. Sanders, School of Agriculture, Cambridge.* 1927-28. 8*s*. *Reprinted from the Journal of Agricultural Science.*—Part I of this study dealing with the effect of the season of the year in which the cow calved has already been reviewed in the JOURNAL (October

1927). The four studies have now been brought together under one cover, and should prove a useful reference for the scientist as well as of interest to breeders.

Effect of Service on Lactations.—The second paper deals with the effect of the length of the service period on the total lactation yield. The Norfolk cows studied by the author had an average of almost exactly one year between calvings.

The average service period was found to be about 85 days, and there was no marked difference between breeds in this respect or between high and low yielders. Following service the yield drops slightly and remains below the level for unserved cows for about 140 days, at which point the cow begins to dry off very rapidly. The writer attributes this not to nutritional causes, but rather to the possibility of its being the outcome of the preparations of the mammary gland for the next lactation, which seems to begin very early in pregnancy, with a definite intensifying of the effect round about the twentieth week of pregnancy. The writer mentions the work of Hammond and others showing that at about the 120th day the secretion from the udders of heifers suddenly becomes honey-like in consistency and the percentage of globulin rises to about 30.

Age.—Part III deals with the variation in the total yield due to age which is measured in the number of lactations. The author points out that it must be remembered that the dry period preceding the second lactation is shorter than the others, while the period during which the cow is served and still milking is longer in the first lactation than for the three subsequent ones, and also that a large proportion of cows calve for the second time from August to December, the period which, as has already been shown, gives rise to the highest yields.

The writer found that farmers kept only their better cows after the fifth lactation. Before there was little selection for high yield. Selection occurred, but the animals appeared to be culled only on the score of appearance, &c.

The maximum yield was reached by Lincoln Reds and unpedigreed cattle at the sixth lactation. Red Polls are slightly later, while the Friesian does not reach its maximum till the eighth lactation, though this last result should be accepted with some reserve. After examining the results of others the writer comes to the conclusion that it is not the number of lactations that a cow has given, but her age in years, which really determines the variation in yield.

The author points to a certain truth in the saying "that a cow is no older than her teeth," attributing the decline of yield after eight years of age to a decline in ability to digest the food properly. He also states that there may be changes in the milk glands. The milk glands are rejuvenated with each pregnancy up to the eighth, when the power of rejuvenation is somewhat lost. He points out that in old age it is persistency rather than capacity which has failed.

The Dry Period.—The length of time that a cow was dry was found to have a big effect on yield, especially in the case of second calvers—the length of the dry period appears to affect the yield, almost equally, throughout the next lactation.

There is a high correlation between the yield of a lactation and the length of the dry period *preceding the previous lactation*. This is interesting, and furnishes one reason for the writer's statement that the dry period has a sort of cumulative effect from one lactation to another.

The average length of dry period appears to be about 40 days. The percentage correlations for second calvers show that if a heifer has calved her second time with a dry interval of only 10 days her yield will be only three-fourths of what it would have been had she had a 40 day dry period. If she had had 10-20 days' rest her yield would still have been reduced by 15 per cent. from normal. For subsequent calvings the differences are not so marked, being 14 per cent. less if the dry period were less than 10 days and 8 per cent. if from 10-20 days. With prolonged length of dry period the yield steadily increases, but it is a question for the farmer himself to decide how long a dry period is remunerative. The practice of 40 days seems wise.

The paper concludes with a discussion and, embodied in an appendix, there are tables for making the required corrections in yield according to variations in the date of calving, length of service period, age and length of dry period. Although the ordinary reader will almost certainly have difficulty in following the mathematical processes by which these results are achieved, he need have no fear of their reliability for English conditions.

The foregoing is a very sketchy outline of a notable piece of work upon the completion of which Mr. Sanders deserves to be congratulated. The science of statistics is a mystical one, but the author has approached it with the necessary caution. The definite conclusions at which he arrives are distinctly

helpful to the practical man in the modern era of milk recording, and should be of assistance in the judging of true yields of animals on which he can found his breeding activities. Moreover the author has paved the way for experiments of a physiological nature. Scientists who follow his suggestions will be wise. It is to be hoped that Mr. Sanders will now direct his activities to a study of the problem of butter fat.

Goats.

Variation in the Duration of Gestation in the Goat. *S. A. Asdell.* 1929. *Jour. Agric. Sc., Vol.* 19, *pp.* 382-396.—The data on which these results are based are taken from the Kid Register of the British Goat Society, giving records for over fifty years to 1923. 6,342 gestations are recorded. The average length is 151 days with a variation from 107 to 200 days. Slight breed differences exist, and there is variation according to time of conception, spring being shorter than autumn. The period is shorter in young than in older dams irrespective of the number of previous conceptions. The size of the litter has no effect on the duration of pregnancy.

ANIMAL NUTRITION.

Nutritive Value of Pasture: IV. The Influence of the Intensity of Grazing on the Yield, Composition and Nutritive Value of Pasture Herbage (Part II). *H. E. Woodman, D. B. Norman, and W. Bee, J. Agric. Sci., XIX, Part* 2, *April* 1929, *p.* 236.—In previous papers the authors discussed the differences in the composition, digestibility and nutritive value of pasture cut at weekly and fortnightly intervals. During the season of the present experiment, the trials have been carried a stage further by the adoption of a system of cutting at three-weekly intervals.

It was found that the adoption of a more lenient system of cutting at three-weekly intervals led to a slight lowering of the percentage of crude protein and a slight raising of the percentages of crude fibre and N-free extractives. On the other hand no corresponding effect was noted in respect of the ether extract, SiO_2 free ash, lime and phosphate, the percentages of these constituents being very similar in the weekly and three-weekly pasture samples.

So far as digestibility is concerned there is little to distinguish grass grown under systems of weekly, fortnightly and three-weekly cuts. Under a system of three-weekly cuts pasture grass never reaches the stage of growth at which lignification sets in, with consequent decline in the digestibility not only of the fibrous constituent, but also of the other organic constituents.

Pasture grass obtained under a system of three-weekly cuts while slightly less rich in digestible protein is nevertheless equal in respect of total digestible organic matter and of starch equivalent to grass grown under systems of weekly and of fortnightly cutting.

Under the system of cutting at three-weekly intervals, the herbage was unable to advance far in maturity, and retained for the most part the appearance of leafiness which is characteristic of young grass in its vegetative and pre-flowering stages of growth.

As regards yield, it was found that cutting at fortnightly intervals produced 29·3 per cent. more dry matter over the whole season than was found under a system of weekly cuts, whilst the yield obtained by cutting at three-weekly intervals was 62·3 per cent. greater than that obtained by weekly cutting.

The Gross Maintenance Requirement of White Leghorns. *H. W. Titus. Poultry Science, VIII, No.* 2, 1929, *p.* 80.—This paper gives an account of preliminary experiments to estimate the gross maintenance requirements of White Leghorn chickens. The expression "gross maintenance requirement" is used here to designate that weight of feed (in grams) which a chicken requires each day for all purposes except for increasing its live weight and for producing eggs. The gross maintenance requirement of White Leghorn hens, 16 months old and weighing on an average 1,632 grams, was estimated as being 64 grams (of the special feed mixture used) per bird per day during July. The amount of the special feed mixture required over and above the maintenance requirement to produce an egg was estimated as being about 40 grams.

Four Feeding Experiments with Silage—II. *A. Amos. J. Min. Agr., Feb.* 1929, *p.* 1020.—An account is given of three experiments with young cattle comparing oat and tare silage with oat and tare hay, and one experiment comparing maize silage with roots. In the three experiments it was found that

the average daily increase in live weight of animals fed oat and tare silage was 1·56 lb. compared with 1·23 lb. of similar animals fed oat and tare hay—an advantage of 0·33 lb. gain per animal per day in favour of silage, and equal to 60 lb. over a period of six months. In the maize silage experiment, in which maize silage was compared with roots on a basis of equal starch equivalents (theoretical), the increases in live weight were to the advantage of maize silage, thus indicating that its actual starch equivalent is at least as good as the theoretical figure.

Rickets in Chicks: III. The Effectiveness of Midsummer Sunshine and Irradiation from a Quartz Mercury Vapor Arc in preventing Rickets in Chicks. *G. F. Heuser and L. C. Norris. Poultry Science, VIII, No. 2, 1929, p. 89.*—An average daily exposure to direct midsummer sunshine at 42·5°N. latitude for 10·9 minutes was sufficient to prevent the development of rickets in chicks and to produce normal growth up to eight weeks of age.

Irradiation from a quartz mercury vapor arc, A.C., at a distance of 36 inches and with an equivalent D.C. operating voltage across the arc of 62 volts for a daily average of 9·1 minutes was sufficient to produce normal growth in chicks up to eight weeks of age, but some indications of the development of rickets was obtained. Complete protection was obtained by irradiating for an average of 13·7 minutes daily.

The effectiveness upon chicks of irradiation from a quartz mercury vapor arc, A.C., at 36 inches and with an equivalent D.C. voltage of 62 volts was not found to be materially greater, if any, than exposure to strong midsummer sunshine.

The measures used in these experiments gave no positive indication of any difference in the effects from exposure to direct sunshine and irradiation from a quartz mercury vapor arc. However, the results of repeated observations indicated that the chicks in the sunshine group possessed greater vigor and smoother plumage than the chicks in the mercury arc group.

Studies on the Nutritive Value of Milk: II. The Supplementary Value of Inorganic Iron and Copper. *W. E. Krauss. J. Dairy Science, XII, No. 3, 1929, p. 242.*—The most serious dietary deficiency in milk is its low iron content, and it would appear that there is an equally serious deficiency of copper. In experiments with rats the author found that ferrous sulphate, ferric citrate, ferric chloride and colloidal ferric oxide, when added to an exclusive whole milk diet, were found ineffective in preventing anæmia in rats. The addition of a small amount of copper (0·16 mgm. daily) as copper sulphate was quite effective. The addition of both copper and iron proved highly effective in preventing nutritional anæmia in rats.

The prevention of nutritional anæmia in rats fed on exclusive milk diet through the addition of small amounts of copper and iron suggests a method for determining the total nutritive effect (apart from reproduction) of milk produced under various conditions, without the use of a basal ration.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in March, April and May 1929.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(*Compiled from Reports received from the Department's Market Reporters.*)

Description.	MARCH.			APRIL.			MAY.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ...	62 2	55 2	42 8	63 11	57 3	43 3	62 4	55 5	43 9
Cross-bred (Shorthorn)	57 8	50 8	37 0	59 4	52 4	38 2	58 2	51 2	40 5
Galloway	56 2	51 0	...	56 11	51 11	..	58 10	53 5	...
Ayrshire	53 3	42 6	33 0	56 4	44 4	34 4	55 0	42 0	31 10
Blue Grey	...	...	...	59 0	...	...	59 6	...	...
Highland	...	...	...	...	...	...	...	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	16¼	10	6	16	10	6	16	10	6
†SHEEP—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	15¾	14¾	11¼	15¾	14¾	11¼	16	14½	11¾
Half-bred	15	14¼	10	15¼	14¼	10½	15	13¾	11
Blackface	15	14	10¼	15½	14¼	10½	15¼	13¾	11½
Greyface	15¼	13¾	10	15½	14¼	10¾	15¼	13¾	11¼
Down Cross	15	14	9¾	15½	14¼	10	15½	14¼	10
†PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	12 11	11 8	...	13 7	12 2	...	14 0	12 10	.
Porkers	13 5	12 1	..	14 1	12 8	...	14 5	13 3	...

* Live weight. † Estimated dressed carcase weight.

Live Stock: Monthly Averages of Prices at certain representative Scottish Markets—*continued*.

Description.	March. 1st Quality	March. 2nd Quality	March. 3rd Quality	April. 1st Quality	April. 2nd Quality	April. 3rd Quality	May. 1st Quality	May. 2nd Quality	May. 3rd Quality
STORE STOCK :—									
Cattle—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.
Aberdeen-Angus :	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	17 1	18 18	12 16	20 18	16 2	12 17	19 15	15 10	12 15
Two-year-olds ...	24 18	20 7	..	26 19	21 7	16 18	27 6	20 16	16 9
Cross-bred (Shorthorn) :									
Yearlings	16 7	13 1	11 12	18 5	15 0	11 17	16 18	13 17	11 11
Two-year-olds ...	23 10	18 9	:..	25 3	19 16	16 6	24 11	18 19	15 14
Galloway :									
Yearlings	12 3	...	...	15 9	...	...	15 1	...	...
Two-year-olds ...	...	17 0	. ...	21 10	17 18	...	27 0	19 5	...
Ayrshire :									
Yearlings	...	...	...	11 0	...	...	13 3	8 10	...
Two-year-olds ...	...	...	...	...	...	...	20 13	12 5	..
Blue Grey :									
Yearlings	...	...	...	...	...	...	...	..	...
Two-year-olds ...	...	...	...	...	...	...	25 5	...	...
Highland :									
Yearlings	...	...	...	...	...	...	...	9 7	6 10
Two-year-olds ...	...	...	...	...	...	...	14 17	11 15	9 0
Three-year-olds ...	...	...	...	...	...	...	20 0	16 8	13 15
Dairy Cows—									
Ayrshire :									
In Milk	27 19	19 19	11 7	28 5	20 6	11 5	29 1	20 7	10 15
Calvers	27 9	20 9	14 0	27 18	20 8	13 18	27 16	20 16	13 14
Shorthorn Cross :									
In Milk	32 10	23 14	...	31 13	22 3	20 0	31 17	24 0	...
Calvers	29 10	20 13	14 14	28 11	20 14	15 4	28 16	21 4	15 8
Sheep—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	54 0	40 10	34 11	50 7	39 11	23 7	50 5	41 8	35 8
Half-bred Hoggs ...	74 0	54 1	53 6	67 7	55 10	52 10	61 5	53 0	50 0
Blackface Hoggs ...	33 3	25 8	27 0	36 11	29 5	22 3	39 7	31 0	25 2
Greyface Hoggs ...	54 5	43 9	37 2	57 9	45 1	38 8	56 5	44 10	40 7
Down Cross Hoggs	...	...	...	...	53 3	...	63 6	48 9	...
Pigs—									
(6 to 10 weeks old)	41 7	27 8	...	47 10	32 4	...	49 6	33 10	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	Quality.	March. Dundee.	March. Edinburgh.	March. Glasgow.	April. Dundee.	April. Edinburgh.	April. Glasgow.	May. Dundee.	May. Edinburgh.	May. Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF:—										
Home-fed—										
Bullock or Heifer ...	1	9⅛	8¾	11	9	9⅜	10¾	9	9⅛	10½
	2	8⅝	...	10¼	8½	...	10⅛	8½	...	9⅝
Bull	1	7¾	7½	7	7½	7⅝	7⅝	7½	7¾	7⅝
	2	6⅞	...	6½	7	7	7⅛	6⅞	...	7⅛
Cow	1	6½	6⅛	6¾	6½	6½	7¼	6½	7	7⅛
	2	5½	...	6¼	5½	...	6⅞	5½	...	6⅝
Irish—										
Bullock or Heifer ...	1	...	...	8½	...	...	9⅛	...	...	9⅛
	2	...	...	8	...	...	8⅝	...	...	8½
Argentine Frozen—										
Hind Quarters ...	1	5½	6⅞	5½	...	7½	6¼	...	7½	6¾
	2	...	5½	5¼	...	6½	5¾	..	6½	6¼
Fore ,, ...	1	4⅞	5	4	...	5½	4⅜	5¾	5½	5
	2	...	4¾	...	..	...	4¼	5⅛	5	4½
Argentine Chilled—										
Hind Quarters ...	1	7	6¾	6⅜	8⅜	7¾	8½	7¾	7½	7¼
	2	6¾	6⅜	5⅞	7⅞	...	8	7⅛	6⅞	6¾
Fore ,, ...	1	5⅛	5	5⅛	5⅝	5¼	5⅝	5¾	5½	5⅝
	2	4¾	4⅝	4⅝	5¼	...	5⅛	5½	5	5⅛
Australian Frozen—										
Hind Quarters ...	1	...	...	5	...	...	6¼	...	...	6¾
	2	...	...	4½	...	...	5½	...	...	6¼
Crops	1	...	...	4	...	...	5⅛	...	...	5¾
New Zealand Frozen—										
Hind Quarters ...	1	...	...	5	...	...	6¼	...	...	6¾
	2	..	...	4½	...	...	5¾	...	...	6¼
Fore ,, ...	1	..	...	4	...	...	4⅜	...	...	4¾
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	12¼	11⅞	12¾	12	12¼	12¾	12¼	12⅝	12⅝
	60 lb. & over	12	...	11⅝	...	...	11⅜	11⅜	...	11¼
,, Cross	under 60 lb.	12¼	11⅞	12⅝	12	12¼	12¾	12¼	12⅝	12⅝
	60 lb. & over	12	...	11⅝	..	...	11⅝	11⅜	...	11¼
Ewes, Cheviot	1	...	9⅛	9¼	...	9⅝	9½	...	9⅛	10⅞
	2	...	...	8¾	...	...	9	...	...	10⅜
,, Blackface ...	1	8¾	9⅛	9¼	9	9⅝	9½	9¼	9⅛	10⅞
	2	8⅛	...	8¾	8½	...	9	8⅝	...	10⅜
,, Cross	1	7	9⅛	8	7	9⅝	8¼	7	9⅛	9⅛
	2	6	...	7½	6	...	7¾	6	...	8⅝
Argentine Frozen ...	1	...	...	5½	..	...	5¾	...	...	6
	2	...	...	5	...	...	5¼	...	...	5⅜
Australian ,, ...	1	...	6⅜	5⅛	...	6⅝	5½	...	6⅝	5⅛
	2	...	5½	5	...	5⅜	5	...	5¾	5
New Zealand ,, ...	1	...	..	6	...	...	6	...	...	6
	2	...	...	5⅛	...	...	5½	...	...	5½
LAMB:—										
Home-fed	1	...	...	13	...	18	18¼	17	18	18⅞
	2	...	...	12½	...	...	17	...	17	17¼
New Zealand Frozen ...	1	...	10½	10½	...	10¼	10	...	10¼	10¼
	2	...	9½	10	...	9⅜	9½	...	9¼	9
Australian ,, ...	1	...	...	9	...	...	9	...	...	9
	2	...	...	8½	...	...	8½	...	...	8½
Argentine ,, ...	1	...	...	8	...	...	8	...	...	8
	2	...	...	7¾	...	...	7¾	...	...	7½

PROVISIONS : Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Department's Market Reporter.)

Description.		Quality.	March.	April.	May.
			s. d.	s. d.	s. d.
BUTTER :					
Danish	per cwt.	1	183 0	166 6	168 7
,, (Unsalted) ...	,,	1	187 0	170 6	172 7
New Zealand	,,	1	176 0	171 6	172 0
,, (Unsalted) ...	,,	1	184 3	177 6	176 2
Australian	,,	1	175 3	169 3	168 7
Swedish	,,	1	176 3	164 3	165 5
CHEESE :					
Cheddar	,,	1	123 6	122 6	121 0
		2	115 6	107 0	*86 0
Cheddar (Loaf)	,,	1	134 0	133 6	131 7
Dunlop	,,	1	120 9	119 6	117 2
		2	110 6	103 3	*84 7
Canadian...	,,	1	112 3	112 0	112 0
New Zealand (Coloured)	,,	1	96 9	96 3	96 0
,, (White)	,,	1	96 9	95 9	94 2
BACON :					
Ayrshire (Rolled) ..	,,	1	142 0	166 6	166 0
Irish (Green)	,,	1	139 0	149 0	143 7
,, (Dried or Smoked)	,,	1	145 0	157 0	149 7
,, (Long Clear) ...	,,	1	133 3	158 0	153 7
Wiltshire (Green) ...	,,	1	143 0	149 0	144 10
,, (Dried or Smoked)	,,	1	150 6	157 0	152 10
Danish Sides	,,	1	117 0	129 0	121 10
Dutch (Green, Wiltshire Style)	,,	1	110 6	122 9	113 0
American, Short Clear Backs	,,	1	96 6	100 6	101 10

Description.		Quality.	March.	April.	May.
HAMS :			s. d.	s. d.	s. d.
Irish (Smoked)	,,	1	184 6	217 0	216 0
		2	169 6	209 0	207 7
American, Long Cut (Green)	,,	1	118 0	123 6	125 5
American, Short Cut ...	,,	1	109 0	116 9	116 5
EGGS :					
Country	per doz.	1	1 11	1 3	1 6
		2	1 10	1 2	1 5
Irish	per 120.	1	18 2	12 2	18 5
		2	16 7	11 3	12 3
,, (Duck)	,,	1	17 6	11 9	12 6
Belgian	,,	1	17 10	11 6	12 5
		2	16 5	..	..
Danish	,,	1	20 2	...	12 6
		2	...	...	...
Polish (Blue)	,,	1	...	9 7	9 7
,, (Red)	,,	1	...	8 9	8 7

* Quotations for New Season's.

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Department's Market Reporter.)

Description.		Quality.	March.	April.	May.
FRUIT:—					
Apples—					
British—			s. d.	s. d.	s. d.
Bramley Seedling ...	per barrel.*	1	16 0	...	...
Other Cooking ...	,,	1	16 9	...	...
Other Dessert	... per case.**	1	11 6	...	...
Imported—					
Newtons ...	... ,,	1	11 9	12 6	13 6
Baldwins ...	... per barrel.*	1	24 0	...	...
Winesaps ...	... per case.**	1	12 0	12 10	13 0
Spitzenberg	... ,,	1	13 0	12 0	12 3
Rome Beauty	... ,,	1	...	11 6	...
Newton Pippins	... ,,	1	12 6	12 0	13 3
Other American	... ,,	1	11 6	10 0	12 0
Other Canadian	.. ,,	1	...	12 0	...
Nova Scotian	... ,,	1	12 0	11 0	...
Pears—					
Californian ...	... ,,	1	16 0	...	...
South African...	... per box.	1	4 6†	7 0‡	5 9¶
VEGETABLES:—					
Beet	... per cwt.	1	8 0	7 9	7 7
Brussels Sprouts	... ,,	1	12 0	10 0	...
Cabbage, Coleworts	... per doz.	1	1 0	1 2	1 3
,, Savoy ...	... ,,	1	2 5	3 3	...
,, Red ...	... ,,	1	4 0	...	..
Carrots, *British* ...	... per cwt.	1	8 0	6 5	6 10
,, *Dutch* ..	.. ,,	1	8 4	...	...
Cauliflowers—					
Broccoli, *Cornish*	... per doz.	1	6 0	5 9	6 4
French ...	... ,,	1	5 11	5 0	5 0
Celery	... per bunch.	1	1 6	1 6	...
Cucumber, *English*	.. per doz.	1	10 0	8 0	6 4
Greens	per 120 heads	1	12 6	12 0	12 0
Leeks	per doz. bunches.	1	3 3	3 0	2 10
Lettuce, Cos ...	... per doz.	1	3 0	2 8	1 11
,, Cabbage	... ,,	1	3 0	3 0	...
Onions, *Dutch* ...	.. per cwt.	1	18 4	7 0	4 0
,, *Valencia*	... per case. §	1	17 0	18 0	...
,, *Egyptian*	.. per cwt.	1	20 0	9 6	8 4
,, *Spring* ...	... per bunch.	1	0 6	0 6½	0 6
Parsley	... per cwt.	1	56 0	60 0	27 2
Parsnips	... ,,	1	11 6	12 0	11 6
Radishes	per doz. bunches.	1	3 0	3 8	3 2
Rhubarb	... per cwt.	1	48 0	44 0	13 0
Spinach	...	1	6 0a	8 0b	...
Tomatoes, *Channel Islands*	per lb.	1	...	0 8	1 0¾
,, *Canary*	... ,,	1	0 4¾	0 5	0 7½
Turnips	... per cwt.	1	2 6	2 6	3 6

* 140 lb. (approx.). ** 40 lb. (approx.). † 7 lb. (approx.). ‡ 25 pears. § 9 stone. ¶ 18 pears. *a* per sieve of 7 lb. *b* per basket of 8 lb.

POTATOES: Monthly Average Wholesale Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Department's Market Reporters.)

Market.		Quality.	Red Soils. Golden Wonder.	Red Soils. Other.	Other Soils. Golden Wonder.	Other Soils. Other.
			£ s.	£ s.	£ s.	£ s.
MARCH — LATE VARIETIES.						
Dundee	per ton.	1	...	...	...	3 15
Edinburgh	,,	1	...	5 10	...	4 10
Glasgow	,,	1	...	3 15	7 10	4 5
APRIL.						
Dundee	per ton.	1	...	...	...	3 15
Edinburgh	,,	1	...	4 5	...	4 5
Glasgow	,,	1	8 10	4 1	7 9	4 2
MAY.						
Dundee	per ton.	1	...	...	...	3 3
Edinburgh	,,	1	...	6 3	...	4 1
Glasgow	,,	1	8 8	3 0	6 9	3 3

ROOTS, HAY, STRAW, AND MOSS LITTER: Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Department's Market Reporters.)

Market.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d	s. d.
MARCH.										
‖ Dundee ... per ton.	1	...	...	22 6	140 0† 130 0‡	...	80 0	...	80 0	52 6*
¶ Edinburgh ,,	1	...	...	...	118 2† 110 0‡	...	57 6	...	57 6	...
‖ Glasgow ,,	1	...	...	...	105 0†	110 0†	75 0	...	70 0	33 9**
APRIL.										
‖ Dundee ... ,,	1	...	...	19 2	140 0† 130 0‡	...	80 0	...	80 0	52 6*
¶ Edinburgh ,,	1	...	...	...	117 6† 110 0‡	...	57 6	...	57 6	...
‖ Glasgow ,,	1	...	...	...	108 9†	110 0†	63 9	...	66 3	34 5**
MAY.										
Dundee ... ,,	1	...	.	18 6	140 0† 130 0‡	...	84 0	...	84 0	52 6*
Edinburgh ,,	1	...	...	...	128 0† 124 0‡	...	59 6	...	59 6	...
Glasgow ,,	1	...	...	...	111 0†	114 0†	60 6	...	65 6	36 3**

‖ Baled Straw delivered. ¶ Bunched Straw delivered.
† Delivered baled. ‡ Delivered loose.
* Foreign (ex quay). ** Home (in $1\frac{1}{2}$ cwt. bales).

Feeding Stuffs: Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	March. Glasgow. per ton. £ s. d.	March. Leith. per ton. £ s. d.	April. Glasgow. per ton. £ s. d.	April. Leith. per ton. £ s. d.	May. Glasgow. per ton. £ s. d.	May. Leith. per ton. £ s. d.
Linseed Cake—						
Home	13 5 0	12 15 0	12 13 9	12 8 9	12 9 0	12 5 0
Foreign	13 5 8	...	12 11 11	...	12 7 3	..
Decorticated Cotton Cake	12 0 0	...	11 19 1	...	11 16 3	10 10 0
Undecorticated do.— Bombay (Home-manufactured)...	8 0 0	7 15 0	7 17 6	7 11 11	7 15 0	7 11 0
Egyptian (do.)	8 10 0	8 1 3	8 7 6	8 0 0	8 5 0	7 15 0
Palmnut Kernel Cake	11 5 0	...	11 5 0	...	11 0 0	...
Soya Bean Cake ...	13 10 0	12 7 6	13 10 0	12 1 3	13 9 0	12 0 0
Coconut Cake ...	12 0 0	..	12 0 0	...	11 19 0	...
Groundnut Cake, Undecorticated— (37 per cent. Oil and Albuminoids)	10 0 0	10 0 0	9 15 0	9 18 2	9 10 6	9 17 6
(40 per cent. do.)	10 4 5	10 5 0	10 5 0	10 5 0	9 17 6	10 5 0
Maize Germ Cake—						
Home	12 0 0	..	12 0 4	...	11 17 0	...
Foreign	12 0 0	...	11 17 6	...	11 14 0	...
Maize Germ Cake Meal	10 15 0	...	10 11 3	...	10 12 0	
Barley Meal ...	10 15 0	10 6 3	10 13 2	10 0 0	10 12 6	10 0 0
Bean Meal	12 7 6	12 0 0	12 4 1	12 0 0	12 3 0	12 0 0
Maize Meal—						
Home Manufactured	11 12 6	11 3 2	11 5 8	11 0 0	10 16 6	10 7 0
South African— (Yellow) ..	11 5 0	...	11 0 0	...	10 15 0	..
(White) ...	10 10 8	...	10 8 9	...	10 5 0	..
Rice Meal	8 10 8	8 5 0	8 11 3	8 0 0	8 3 0	7 13 9
Locust Bean Meal (Fine)	10 6 3	9 15 0	10 11 11	9 9 5	10 12 6	9 10 6
Fish Meal	20 0 0	20 0 0	19 10 0	20 0 0	19 10 0	20 0 0
Maize Gluten Feed (Paisley) ...	10 10 0	..	10 5 0	...	10 1 0	...
Maize—Plate ...	10 18 2	10 12 6	10 11 3	10 5 0	9 19 6	9 11 6
Do. American ...	10 11 3	10 5 0	10 2 6	...	9 19 6	...
Oats—Home ..	9 15 8	9 2 6	9 15 8	9 8 9	9 12 6	9 5 0
Do. Plate ...	9 8 2	...	9 2 6	..	8 18 6	...
Barley Feeding (Home)	10 17 6	9 5 8	10 15 0	9 10 0	10 7 0	9 5 0
Do. Bran ...	10 5 0	...	10 5 0	...	10 2 0	...
Wheat—						
Home	11 5 0	10 1 3	10 14 5	10 0 0	10 9 0	9 11 6
Poultry	10 3 9	10 0 0	10 1 11	10 0 0	9 15 0	9 7 6
Imported ..	9 5 0	..	9 5 0	9 5 0	8 17 6	...
Middlings (Fine Thirds or Parings)	9 8 9	9 1 3	8 16 3	8 13 9	8 10 6	7 12 0
Sharps (Common Thirds) ...	8 8 9	8 5 0	7 19 5	8 2 6	7 8 3	7 11 0
Bran (Medium) ...	8 17 6	8 8 9	8 8 9	8 1 3	7 7 6	7 2 0
,, (Broad) ...	9 0 8	9 3 4	8 12 6	8 16 3	7 11 9	7 17 0
Malt Culms... ...	8 10 0	8 0 0	8 5 0	...	8 2 0	7 17 3
Distillery Mixed Grains—Dried	...	9 16 3	...	9 15 0	...	9 10 0
Brewers' Grains— Dried	...	8 15 0	9 15 0	8 15 0	9 14 0	8 8 6
Distillery Malt Grains —Dried	9 6 3	...	9 15 0	...	9 11 0	...
Crushed Linseed ...	21 0 0	...	21 0 0	..	21 0 0	...
Locust Beans, Kibbled & Stoned	9 10 0	9 0 0	9 10 0	8 14 5	9 10 0	8 15 6
Beans—English ...	12 10 0	...	12 7 6	...	...	...
Do. China ...	11 6 11	11 7 6	11 0 0	...	11 3 6	...
Do. Sicilian ...	11 5 0	10 17 6	11 0 0	...	11 2 9	...
Pease—Calcutta (White)... ...	13 5 0	...	14 0 0	...	14 0 0	..
Feeding Treacle ...	7 5 0	7 5 0	7 3 9	7 3 9	7 0 0	6 16 3
Linseed Oil per gall.	0 4 0	...	0 4 0	...	0 4 0	...

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	March. Glasgow.	March. Leith.	April. Glasgow.	April. Leith.	May. Glasgow.	May. Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda § ...	N. 15½	10 11 0	a10 10 0	10 12 0	10 9 0	10 12 0	10 11 5
Nitrochalk ‖ ...	N. 15½	10 0 0	..	10 0 0	...	‖10 0 0	a10 0 0
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	10 13 0	10 12 0	10 12 0	10 12 0	10 12 0	10 12 0
Superphosphate ¶ ...	P.A. 13·7	2 7 6	...	2 7 6	...	2 7 6	..
,, ...	,, ,,	...	2 12 6	...	2 12 6		2 12 6
,, ¶	,, 16·0	2 12 6	...	2 12 6	...	2 12 6	...
,, ...	,, ,,	..	2 17 6	...	2 17 6	...	2 17 6
,, ...	,, 17·4	...	3 2 6	...	...	...	. .
,, ...	,, 18·3	...	3 5 0	...	...	...	...
Ground Mineral Phosphate † ...	P.A. 25½	2 7 6	...	2 7 6	...	2 7 6	...
Potassic Mineral Phosphate	P.A. 18 Pot. 5	..	3 5 0	...	...	...	...
,, ,,	P.A. 18 Pot. 10	...	3 11 3	...	...	...	...
Kainit (in bags) ...	Pot. 14	3 7 6	3 3 9	3 7 6	3 3 9	3 7 6	3 3 9
Potash Salts ...	Pot. 20	3 17 6	3 12 6	3 17 6	3 12 6	3 17 6	3 12 6
,, ,, ...	Pot. 30	5 5 0	5 1 3	5 5 0	5 1 3	5 5 0	5 1 3
Muriate of Potash... (on basis of 80 per cent. purity)	Pot. 50	9 12 6	9 2 6	9 12 6	9 2 6	9 12 6	9 2 6
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 15 0	11 3 9	11 15 0	11 3 9	11 15 0	11 3 9
Steamed Bone Flour	N. 0·8 P.A. 27½/30	6 5 0	6 2 6	6 5 0	6 0 8	6 5 0	6 0 0
Bone Meal, Home ¶	N. 3·3 P.A. 22·9	7 15 0	...	7 15 0	...	7 15 0	..
,, ,, Indian ¶	N. 3·75 P.A. 22·9	9 5 0	...	9 5 0	...	9 5 0	..
Basic Slag * ...	P.A. 11	2 1 9	...	2 1 9	...	2 1 9	...
,, ,, * ...	,, 12	2 2 9	...	2 2 9	...	2 2 9	...
,, ,, ...	,, 12	...	...	...	...	...	..
,, ,, * ...	,, 13	2 3 9	...	2 3 9	..	2 3 9	...
,, ,, ** ...	,, 13	...	1 12 6	...	1 12 6	..	...
,, ,, * ...	,, 14	2 5 9	...	2 5 9	...	2 5 9	...
,, ,, ...	,, 14	...	**1 14 6	...	a2 12 6	...	a2 12 6
,, ,, * ...	,, 15	2 7 9	...	2 7 9	...	2 7 9	...
,, ,, a ...	,, 16½	...	3 2 6	...	3 7 6	...	a3 7 6
,, ,, b ...	,, 18	...	3 7 6	...	3 11 8	...	b3 12 6

Abbreviations :—N. = nitrogen ; P.A. = Phosphoric Acid ; Pot. = Potash.

* 75 per cent. to 80 per cent Citric Soluble Phosphates ; carriage paid in 6-ton lots to Lanarkshire and Renfrewshire stations. ** On rail at Grangemouth.

† Fine grist 80 per cent. fineness through standard 100 mesh sieve.

§ Carriage paid in 6-ton lots. ‖ Carriage paid in 2-ton lots. ¶ F.o.r. Glasgow.

a. At Leith. *b.* Belgian slag at Leith.

Printed under the authority of HIS MAJESTY'S STATIONERY OFFICE
By J. Skinner & Co., Ltd., Thistle Street, Edinburgh.

(6999.) Wt. 10641/1283. 1500 + 49, pp. 331-347. 7.29. J.S.&Co.,Ltd. G.18.

The Scottish Journal of Agriculture.

VOL. XII.—No. 4.] OCTOBER 1929. PRICE 1s. NET.

AGRICULTURE AND THE EMPIRE.[1]

SIR ROBERT B. GREIG, M.C., LL.D., M.Sc.,

Secretary to the Department of Agriculture for Scotland.

IN this country, which Kipling has described as "the last and the largest Empire, the map that is half unrolled," a Pan-African Congress of Agriculture is meeting side by side with the Agriculture Section of the British Association, which is an Imperial Body for the advancement of science.

The Imperial aspect of Agriculture is surely therefore a subject for consideration and discussion.

Membership of an Empire such as ours is, like freedom, a noble thing. The mere size of the Empire grips the mind and makes an emotional appeal which, when fully realised, is a step towards a unified world. The Empire is so widespread and so various that it can accommodate every kind of mind or body. A man feeling cramped in Scotland can find room in South Africa. He who finds his intellectual horizon limited in New Zealand may find his spiritual home in Oxford or in Edinburgh. Because the Empire includes so many diverse peoples differing in physical and mental attributes, and because it yields such a variety of natural products it offers problems political, social, and industrial, of peculiar interest and complexity. It can provide greater facilities than can small homogeneous units, for within the Empire is every kind of external stimulus that goes to promote mental development and intellectual advancement.

Moreover, its political structure is of peculiar advantage. The free nations of the Commonwealth, along with the great non-self-governing territories, can meet without difficulty or embarrassment for the discussion of common problems. They have a focal point or centre in England from which concerted action may, if desired, be taken. When action is taken they have the largest outdoor laboratory in the world; a field for action which allows in some part or parts the investigation of problems of almost every description.

But citizenship of the Empire involves responsibilities. The principle of trusteeship is admitted. The governments are trustees for rich territories covering nearly a quarter of the globe. They are also responsible for hundreds of millions of native

[1] Presidential Address to Section M. (Agriculture) of the British Association, delivered at Pretoria, August 1, 1929.

populations. These native populations can rise in the scale of civilisation only according as they may be influenced by education, sanitation, law and order. But these influences can be exerted only in proportion to the prosperity of agriculture and industry. In our colonial Empire in the past we have concentrated chiefly upon administration and we have reason to be proud of the results. But the native populations will judge us in the future not by the excellence of our administration but by the means we take to help them to a higher standard of living and to secure for them some of the benefits of civilisation. We, then, as citizens, are bound to develop the Empire even for the sake only of the native populations. Finally, we are trustees to the world in general as custodians of so great a part of the world's wealth.

The progress of civilisation depends upon science, not science stated crudely as chemistry or botany, but the scientific spirit applied to all aspects of life. If science is applied to the economics of the Empire, the greatest economic asset to which it can be applied is agriculture. From the standpoint of area, or wealth, or population employed, agriculture is by far the most important activity in the Empire. The true wealth of the world, the wealth which determines the standard of living of nations, is limited by the capacity to produce cereals, milk, meat, wool, cotton, hides, and other prime necessities of life of soil origin; without a sufficient supply of these progress in the art of living is impossible. Agriculture is also the one stable industry. Coal seams come to an end, or the discovery of new sources of energy changes the values of coal. Advances in physical science may, while creating new industries, destroy old ones. The wealth of gold and diamond fields depends upon artificial values which might disappear if society were constituted on a new basis with a different monetary system and different culture. But agricultural wealth, the capacity to produce every year the food and clothing without which life ends, is and always has been the one great permanent industry, the one which is the foundation of all national or indeed of world wealth.

THE EXTENT OF EMPIRE AGRICULTURE.

The British Dominions, India and the Colonies cover 24 per cent., or nearly one-quarter of the globe, and they contain 24 per cent., or nearly one quarter of the world's population.

Of this immense area no precise measure of the full extent of land in agricultural use is available, but the proportion is small. The most intensively cultivated of the larger areas is India, the least intensively cultivated is Australia. (See Table I.) In the aggregate only 8·7 per cent. of the total land surface of Canada, India, the Union of South Africa, Australia and New Zealand is under arable cultivation. Only about one acre in every hundred of Australia is under cultivated crops, about two and a half acres in Canada, and three acres in South Africa and New

Zealand respectively. It is difficult to obtain figures indicative of the possibilities of the tropical and sub-tropical territories, but the African possessions alone are capable of enormously increased production.

In the nine provinces of Canada the "possible farmland" is 358 million acres, or about one-quarter of the total land area of the provinces, and five and a half times the present total of both arable and pasture. In India, the most intensively cultivated, it is estimated that the cultivable waste land is equal to half the present cultivated area, or about 153 million acres.

Some evidence of the importance of the grasslands of the Empire is obtainable from the numbers of the world's live stock. (See Table II.) Of every hundred head of cattle in the world, forty-four graze on Empire pastures, and of every hundred sheep, thirty-eight are in the Empire. Australia and New Zealand together own approximately as many sheep as the whole of Europe, excluding the United States of Soviet Republics. Evidence of what the Empire might do in grassland products is provided by the figures of imports of live stock products into Great Britain. The British market imports £330,000,000 worth of grassland products annually, which is about one-quarter of the imported goods of all descriptions. Of these foodstuffs which come from the grass, one-half, or about £160,000,000, come from the Empire.

It is easy to realise the importance of agriculture in Canada or Australia, but in an industrial and mineral country such as Great Britain and in a great mineral-producing country such as South Africa, the place of agriculture is apt to be overlooked. (See Table III.) In the three larger Dominions and even in Great Britain, agricultural production is more valuable than mineral production. It may be astonishing to some to learn that Great Britain, including Northern Ireland, produces more agricultural wealth than Australia and four times as much as South Africa. When the value of minerals is combined with the value of manufactures, even then the agriculture of Canada and Australia is more important than minerals and manufactures combined. The dependence upon agriculture for the prosperity of the overseas trade of some of these countries is striking. (See Tables IV and V.) Of New Zealand's produce exports, for example, 89 per cent. are agricultural and only 11 per cent. non-agricultural. The produce exports of Australia show 84 per cent. to be agricultural; while from South Africa, only 31 per cent. are agricultural, and from Great Britain less than 3 per cent.

The distribution of the population dependent upon agriculture is best shown by such countries as South Africa, India and Nigeria. In South Africa, in spite of its small agricultural and great mineral production, 37 per cent. of the population are engaged in agriculture and only 5 per cent. in mining. In India 72 per cent. are dependent upon agriculture and in Nigeria (which is three times the size of Great Britain, and one-third of the size

of British India), practically the whole population depends on agriculture.

It is obvious that a vast area of the Empire is capable of further production, even if developed only on the present lines with the application of existing knowledge. But if we apply not only the science now at our disposal but the results of further researches and investigations which are sure to follow, the potentialities become almost incredible.

Relation of Science to Agriculture.

Let us come now to the relation of science to agriculture. Agriculture can be regarded as the application of all the sciences to the exploitation of the soil. There is scarcely a branch of pure science which may not contribute some knowledge which agriculture can apply. But agriculture differs from other industries in which a new discovery may be followed by a sudden transformation in methods. Agriculture is old, slow-moving, and conservative. The life cycle of animals runs into years, and even in cropping a rotation of years must often be followed to get the full effects of any change of method. Hence the results of research are absorbed slowly and almost imperceptibly into farming practice. Nevertheless there have been numerous instances when the advance has been so rapid that the farmers applying the knowledge have been within sight of the source of the knowledge.

The case of " Marquis Wheat " is well known. This wheat, bred by the Canadian Experimental Station at Ottawa, has by its earlier maturity and superior cropping powers, not only ousted the older and inferior varieties of wheat in millions of acres of Canada and the Northern United States, but it has made the cultivation of wheat possible in areas where wheat could not be grown before.

A variety of sugar cane has recently been produced in Java by the Dutch Plant Breeders; one of its ancestors was not a sugar cane at all but a wild reed growing in a marsh. Yet this variety partly of reed ancestry is greatly superior to any other, giving 15 per cent. to 20 per cent. more sugar and resisting local diseases better than any other. Most of the sugar fields of Java are now growing it. The sugar production of Java since 1840 shows the following increase and offers one of the finest examples of the effects of the application of science to plant breeding, manuring and cultivation. (Five-year periods—average for each five years.)

1840-45	24	piculs per bouw.
1865-70	50	,, ,,
1900-05	100	,, ,,
1920	120	,, ,,
1925	132	,, ,,
1928	150	,, ,,

Comment is superfluous.

The grasslands of the Empire, as I have shown, support at least 500,000,000 animals. If all these animals were suited to their environment, free from disease and sterility, and sufficiently nourished, their value would be far more than doubled or trebled. South Africa, through Sir Arnold Theiler and his staff, has already demonstrated to the full part of this possibility. In discovering the cause of and the means of combating certain insect-borne diseases, Sir Arnold and his associates have saved the Union millions of pounds. Equally spectacular is the biological control of noxious weeds, such as the prickly pear in Australia and the blackberry in New Zealand. In the field of animal nutrition, it has been discovered that diseases may be caused in farm stock by the absence of minute quantities of iodine, lime, phosphorus or vitamins. The cure of rickets in pigs, and styfsiekte and lambsiekte in cattle, by the administration of bone meal and salt and other mineral mixtures has already saved hundreds of thousands of pounds to stock farmers. The application of the newer conception of the balanced ration which we now have as the result of the studies of physiologists and biochemists, is yielding its return in increased production.

The intensive management of grassland in such great grazing countries as Australia, New Zealand and Great Britain is only beginning, but already it is plain than production can be doubled under skilful management. Even the fertiliser or artificial manure concerning which we know more than of almost any other agricultural improvement has far wider fields to conquer than any which it has yet subdued.

These great achievements give us the assurance that the application of pure science to agriculture will yield results of a value many times greater than the money expended.

The Empire as an Organism.

If my figures and arguments are accepted, the British Empire must be regarded as an amazing organism. Is this organism developing symmetrically and is it desirable to take thought as to its development? It may be argued that no great thought is needed, that each part of the Empire, left unfettered in the pursuit of well-being in its own way, will eventually provide the best conditions for its inhabitants. But this argument totters in face of the Canadian Wheat Pool, which sooner or later will compel the wheat-growing parts of the Empire to consider their ways and to come to an arrangement whereby the Empire wheat comes under some uniform system of organised production and orderly marketing. The argument is further confuted by the fact that South Africa has joined with Australia and New Zealand in a great co-operative marketing and purchasing agency in London, known as Overseas Farmers' Co-operative Federations, Ltd. These straws show the way the wind blows, and make it unnecessary to labour the point, for few will hold that nothing is to be gained by co-operation in effort. If that be so

the question that occurs to me as an official concerned with agricultural development is, what share, and it must be a very large share, can research applied to agriculture take in the proper growth and nurture of the organism.

In the first place it is clear that there are large economic problems affecting all parts of the Empire which await solution if the Empire is to be properly developed. There is, for instance, sterility and abortion in live stock. There is the pasture problem. There are insect-borne diseases. It is almost hopeless for a single individual or even a single institution to attempt the solution of any of these great problems. Each problem has so many aspects that team work is needed in the widest sense—not only between individuals, but between institutions and between governments.

In the case of sterility and abortion in cows for instance, there is here first a problem for the bacteriologist and the pathologist, as the micro-organism which causes contagious abortion is probably the most important factor. There is a nutritional factor, as it is well known that deficiencies in the diet cause both sterility and abortion, and may also render the animal more susceptible to the invasion of the organism. Moreover, in this as in other diseases, there is a problem for the geneticist, to discover to what extent, if any, is the tendency inherited and what may be the correlated factors which indicate the susceptibles and the highly resistant strains. Finally, if or when the knowledge arrives which makes possible the elimination of the disease, the co-operation of the administrator is required to frame and execute the regulations recommended by the scientists.

The most recent development of the work on pastures has been in connection with their chemical composition. It has been shown that chemical composition, if it takes account of all known food constituents, is an indication of the feeding value of pastures, and it has been proved independently in various parts of the world that deficiencies of one or other nutrients required only in small amounts, are the cause of definite diseases. Further, it has been shown that if these deficiencies are made good, not only are the diseases prevented, but production is increased and there is reason to believe that susceptibility to disease generally is decreased, and what is also of great economic importance, animals breed true instead of undergoing the well-known deterioration which takes place in improved breeds when put upon poor pastures. The better exploitation of the pastures of the Empire is a problem which requires, for a complete investigation, the pathologist and bacteriologist to deal with the diseases which occur in deficient areas; the physiologist and biochemist to deal with the composition of the pasture and to determine to what extent it meets the requirements of the grazing animal. There is needed also the work of the plant breeder and the soil chemist for the improvement of the pasture as a crop.

To bring about a concerted and co-operative attack upon such problems as these a certain procedure seems desirable, but

before suggesting that procedure, let me point out that the facilities for co-operation are now immeasurably greater than they were even thirty years ago. Rome fell from various causes, but no doubt one of its defects was the absence of newspapers and telegrams by which the outlying parts of the Empire might have been kept in communication in time to avoid or avert some of its disasters. We have no such excuse. Communication is easy, transport is easy, conference is easy. In many ways Pretoria and London, and Ottawa and London are nearer to each other to-day than London and Edinburgh were 150 years ago. Moreover, a foundation for action exists which did not exist in the nineteenth century. In many parts of the Empire and especially in the self-governing Dominions, research has been going on in agriculture for a generation or more, and a great body of knowledge has been built up, much of which can be applied.

The Procedure for Empire Research.

Provided, then, that we have a large enough conception of Empire development by research the procedure should be :—

(*a*) to outline the problem;
(*b*) to collect all available information concerning it;
(*c*) to make a plan of campaign;
(*d*) to find the money to finance the research;
(*e*) to find the men to do the work.

To carry out this procedure it so happens that we are in a more favourable position than ever before in the history of the Empire. The urgent problems that arose during the war demanded a solution on immediately practical lines. Tremendous advances were made in some of the applied physical sciences, as a result of the fact that all scientists who could contribute to the solution of an urgent problem were brought together and urged to work in such a way that their energies were focussed on a known objective. Following on this war experience, a similar spirit of co-operation has been developed in agricultural science. It is interesting to trace how this spirit has been stimulated and encouraged.

In 1925 the British Government set up an Imperial Economic Committee, with an annual grant of £1,000,000, for the purpose of encouraging trade in Empire products in the United Kingdom. The Imperial Economic Committee recommended that the annual grant should be used, first, to create in the United Kingdom a voluntary preference for Empire goods, and, second, upon research to improve the quality and supply of Empire goods for sale in the United Kingdom. The British Government, after consultation with the Dominion Governments, accepted the Report and created the Empire Marketing Board, which is the executive body for the administration of the funds. The Empire Marketing Board early turned its attention to the encouragement of research as the second of its functions.

Almost simultaneously with the creation of the Empire Marketing Board was set up the Committee of Civil Research, consisting of the Prime Minister and the Lord President of the Council, with power to set up *ad hoc* sub-committees for any purpose other than military. Here, then, we have already two bodies calculated to assist in the procedure which I have outlined. The Committee of Civil Research, flexible enough to inquire into and report upon any non-military subject under the sun, and the Empire Marketing Board—a body with funds to finance research.

It was borne in upon those who had inquired into research in the non-self-governing Colonies that much good work was lost in pigeon holes, that scientists were sometimes engaged on the same problems unknown to each other, that overlapping occurred, and that facilities for the exchange of information were inadequate. Accordingly, when the Imperial Agricultural Research Conference was held in London in 1927, influenced as it was by the great success which had followed the formation of the Bureaux of Entomology and of Mycology, it strongly recommended the creation of clearing stations or Information Bureaux for the collection and distribution of information concerning certain sections of agricultural research. The proposal found acceptance with the British and Dominion Governments and with the Colonies, and several of these bureaux are now in operation. I believe that they will prove of extraordinary value in the development of the Empire. They are eight in number for the present. How far they may be added to, experience will decide. They are all, by the unanimous decision of Empire delegates, situated in Britain. They deal with Soils, Animal Nutrition, Animal Genetics, Animal Hygiene, Plant Breeding, Animal Parasitology and Fruit Production. They are not research institutions, but in each case they are attached to research institutions, and their first directors are the directors of the research stations.

Each bureau will focus the information on the subject—will act as a gathering ground for theories and theorists, as an illuminant and expositor, and eventually we may hope, as a finger-post to new and profitable roads and by-paths of research. These bureaux, to which all Governments of the Empire have agreed to contribute, embody the first organisation which is Imperially owned and Imperially governed, and which has been set up to serve the Empire.

The Bureau of Soils at Rothamsted, or of Animal Genetics at Edinburgh, is just as much the property of South Africa and Australia as of England or Scotland; and England and Scotland sit on the Executive Council as representatives only of their countries.

It is not enough, however, to accumulate details. It is foolish to make a list of the stars and remain content with the catalogue. The details must be followed by a synthesis to sum up and explain the details, and arising out of the synthesis will appear

the clues to some problems, the explanation of others, and the broad lines of strategy on which the research battalions should move. Each Dominion or Colony has its own problems peculiar to its conditions, but the fundamentals of science are everywhere the same.

In addition to the researcher, it is then necessary to have other types of scientific workers. The research worker is properly and sufficiently engrossed by his speciality. He seldom has time for or interest in the wider conceptions. His point of view is generally limited by his subject. But the application of science is not confined to the research worker. The broad results of research can be understood by politicians who can set the wheels in motion through their Governments. Scientific men are wanted who can see the wood without the trees, who can see the possible bearing of unconnected facts, and who can use their imagination at long range. Such men if they use the scientific method are as truly scientific as the researcher himself.

We have then machinery to deal with three of the five necessities for Empire Research. We have the bureaux to collect information. We have the Committee of Civil Research to consider the information and plan a campaign, and we have the Empire Marketing Board to provide the funds. There remain to be considered the men, and the origin of the problem.

As to the men, the great Dominions can and will provide and train their own men. The success of South Africa in the production of research workers whose reputation is world wide is sufficient evidence of what the Dominions can do. The case is different in the Colonies. As a rule, the research workers in the Colonies must be recruited from Home or Dominion sources and partly trained outside of the Colonies which they serve. Much has been written concerning the need for these workers, their status, pay and pension. It is enough to say that the development of the tropical and sub-tropical possessions depends upon making the career of a colonial research worker as satisfactory as the alternative, less interesting, and perhaps more sordid business of making a living. There is one aspect of the man power that must not be lost sight of in considering Empire research, and that is the desirability of exchange of workers. Nothing can be more profitable and stimulating in suitable circumstances than change of environment to the research worker. He obtains a new lease of scientific life, a wider outlook, a wealth of experience of men and methods denied to him as a limpet in an institution. There are difficulties in the way of exchanging workers on any considerable scale, but these difficulties will decrease as time passes and the temporary exchange of work and of workers will prove of far-reaching benefit.

The Problem.

I come now to the Alpha and Omega of research—the beginning and the end—" The Problem." It might be assumed from

some of the foregoing remarks that, like many an administrator before me, I have been erecting a rigid structure into which I proposed to fit a flexible and incalculable body. Far from it, wide experience shows that the feet of research cannot be crammed into the shoes of regulations. One knows where the shoe pinches.

The facilities I have described arise from the recognition of the value of co-operation in research by Governments, and from the desire for co-operation in research on the part of the workers. The structure is an arrangement for the assistance of research, not a frame in which to fit it.

The problem in which these organisations have been created to help to solve may arise in various ways. It would be easy to mention many outstanding Imperial problems, but assuming that some individual research worker in some corner of the Empire has seen or shed new light on some obscure point, what is his happy condition to-day compared with twenty years ago? Through the bureaux or clearing centres of information, he can mobilise all the existing knowledge bearing on his point. Armed with this knowledge, he sees that the scope of the required research is far beyond his individual powers. If he is in one of the Dominions he can put his case before the Department of Agriculture or, it may be, before the Department of Scientific and Industrial Research of his Government. The Department can bring together the best brains available to consider and report upon the necessary research, or in the case of Great Britain and the Colonies, the Committee of Civil Research can undertake the inquiry. A plan of campaign is ultimately worked out. The Empire Marketing Board is approached and the funds jointly provided by the Board and the Dominion or Colony chiefly concerned. The men are then selected, possibly from the whole Empire, and seconded for the work, the locus is decided upon and the attack begins. In this case the problem has originated through the vision of one individual.

Take another case, where the problem originates at the other end of the scale. Take a simple illustration. Suppose, and this is probably true, that the sheep on the hill grazings of Scotland and England have diminished by one-third in fifty years. The Agricultural Administrator concerned appeals to the Research Institutes. They reply that there are probably half a dozen factors contributing to the decrease. Then follows the inquiry, the suggested plan of campaign, the funds, the men, and the attack. Yet out of such an investigation may arise the information which will enable principles of general application to be determined regarding sheep and pastures over half the world. Here the administrator has set the ball a-rolling.

But the politician, or to give him a worthier name, the Statesman, is not out of the swim. Let us suppose that South Africa wishes to take a large share in the supply of chilled beef and mutton to the great industrial centres of England. Immediately there arises a problem economical, genetical, nutri-

tional, pathological and botanical, which can only be solved by the combined operations of a number of scientific and business men working together.

Finally, there is another way in which the problems may arise. That is through the deliberations of a long range thinking body not concerned with the problems of to-day or even the immediate to-morrow, but with research which has no present relation to agricultural practice but which may prove a fertile source of lines of investigation ultimately of the first importance to agriculture.

We have then available organisations or machinery capable of doing great things for the development of the Empire. Already much has been achieved. The Empire Marketing Board in two and a half years has made grants up to the end of 1928 aggregating a million and a half. The spread of these grants as seen from the map and table are interesting. A fine example of what has already been done in Imperial team work is offered by the Grassland Research.

The headquarters of this research is in Aberdeen and the Chief of Staff is Dr. Orr. Under his direction, teams have been investigating the mineral deficiencies of pastures in Kenya, in the Falkland Islands, in Palestine and in Scotland and England. Arising out of these investigations and those of Sir Arnold Theiler, similar campaigns have been started in Australia and New Zealand. Here in the space of only two or three years we have through vision and staff work an Imperial Investigation which promises to increase enormously the output of beef and mutton from Imperial grasslands.

As a result of these pasture researches the workers engaged have been in consultation with each other and a spontaneous tendency to co-operation is bearing fruit. In consequence the pioneer work of Onderstepoort is known and appreciated in Great Britain and elsewhere and is being applied successfully. The work of Aston in New Zealand on "Bush sickness" is being applied in East Africa. The Canadian work on the prevention of goitre in grazing animals is a stimulus to work in other countries such as Australia and New Zealand where there is believed to be a deficiency of iodine in the pastures. If similar developments can take place in other lines of research there is a possibility of great advances during the lifetime of the present generation.

I hope I have said enough to show that the application of science and commonsense to the development of the Empire and particularly of its agriculture, promises rich rewards.

New Adjustments.

As it seems probable that great adjustments will need to be made in methods of agriculture, and in the organisation of supplies, it seems essential that while we have the time we should think Imperially and think ahead. The International Economic

Congress at Geneva in 1927 diagnosed the depressed condition of European agriculture as being due to unremunerative prices. The Congress negatived the conclusion that the fall in prices was due to any excess of production. It was, on the contrary, of opinion that, relatively to the growth of population, there has been no increase in output over that of 1913. With this opinion Sir Daniel Hall, as shown by his address at Oxford in 1926, would agree.

Lord Ernle, the Minister of Agriculture during the war, said recently: "The question has already arisen how far it is safe in the world's interests to allow the decline of agriculture. Workers once attracted to the towns never return. Inevitably in course of time, whether sooner or later, it is impossible to predict, nations will be feverishly striving to rehabilitate agriculture under the overmastering influence of food shortage."

This opinion of Lord Ernle's may be somewhat pessimistic, but local famines do occur. In Kenya there was a partial famine this year. Famines are recurrent in India, and many thousand people in Ireland died of famine less than a hundred years ago.

On the other hand we have Mr. Speyer stating in *Nature*, January 12, 1929, with reference to the manufacture of nitrogen fertilisers from the air, that if the nitrogen supply which is in prospect by 1931 were applied to the main crops of Europe at the rate of ·8 cwt. per acre, the population at that date would not consume more than half of the extra food which would thus be available. We have also Professor Stewart, formerly of the Minnesota Agricultural College, asserting that since 1850 machine farming developments have released approximately twenty-seven million workers from agriculture. He also states that with two-horse machinery forty hours of labour were required to grow a crop of maize, but now with modern machinery less than four hours of man labour per acre are required.

Whatever may be the significance of these opinions or the ultimate value of these statements one thing certain is that the development of the agricultural resources of the Empire is of the first importance.

The Opportunity.

We have the only system of government in the world that can link up research in countries with all kinds of soils and climates. We have the finest and most varied laboratory in the world. We have the nucleus of an organisation and we have the opportunity.

Within the Empire is the Empire's greatest market for agricultural produce and the Empire's greatest source of supply. The development of agriculture would have an enormous influence in the development of Empire trade. Co-operation in research leads to better understanding between the Dominions, the Colonies, and the Mother Country. Conferences of research workers and administrators lead to the discovery of common

aims and ideals, as was shown in the Conference of 1927, and the pursuit of common aims is one of the most enduring of ties. But the scientific man knows no boundaries; he is one of the few real internationalists in the world to-day; the knowledge he obtains is subject to no tariff, receives no bounty, is freely exchangeable throughout the world. As a scientific man—if he is within the British Empire—he may engage in the solution of larger problems than probably any other unit can provide.

And what may be the end of his research? One may speculate, but the end should surely include an orderliness, a co-ordination of parts, and a relationship of functions which should make for greater prosperity and for greater stability and freedom from temporary over- or under-production of agricultural commodities. It is not suggested that the exchange of commodities should be intra-imperial. Even if that were desirable it is not possible. The trade of the Empire is shared almost equally between the Dominions and foreign countries. (See Table VI.) It is not that the Empire may be a self-contained and self-supporting quarter of the globe that I make these suggestions. To succeed in such an aim would be to end nowhere or to end in destruction. I make these suggestions because the nations which make up the British Empire form a political body which faces an opportunity open to no other system of governments in the world. This opportunity is the possibility that by taking thought and by organising the acquisition and the application of knowledge, the wealth of the Empire can be greatly increased, and thereby, and necessarily, the wealth of the rest of the world will be increased also. It is a far cry to an organised Empire, but if the object is worth it, the initial step is to adopt the "viewpoint" described by General Smuts. With the view-point and the mental field surrounding it come the creative ideas which in the end realise the dream. What I plead for then is the "view-point." Even in the prosaic occupation of agriculture, of the earth earthy, I suggest that the Imperial view-point is stimulating and creative.

The conception of an organised agriculture based upon science should, I think, be part of the mental equipment of every statesman and administrator. The same vision should inspire every research worker if, in the words of the late Lord Morley, he is to weave the strands of knowledge into the web of social progress.

If the vision is keen enough, the conception wide enough, the energy enduring, and the courage unfailing, is it not possible that the group of free nations which constitute the British Empire may demonstrate the means and lead the way to that wider world government to which every generous and contemplative mind would look.

[TABLE. I.

TABLE I.

Land returned as arable in the following countries.

COUNTRY.	1000 acres.	Percentage of Total Area.
Great Britain	13,500	24·0
Northern Ireland	1,180	35·6
Irish Free State	3,640	21·7
Canada	56,400	2·4
India (British)	300,000	45 8
(Native States)	80,000	59·1
Union of South Africa	9,400	3·1
Australia	22,500	1·2
New Zealand	2,000	3·0

TABLE II.

Live Stock of the Empire.

	World Total (1927) omitting China and a few other areas.	Empire Total (1926) including Great Britain and Mandated Territories.	Percentage of World Total.
Horses . .	102,000,000	11,000,000	11
Cattle . .	560,000,000	245,000,000	44
Sheep . .	650,000,000	245,000,000	38
Pigs . .	205,000,000	11,000,000	5

Sources of Information.

"International Yearbook of Agricultural Statistics, 1927 28"

"Statistical Abstract for the British Overseas Dominions and Protectorates (Cmd 3198), 1928"

"Agricultural Statistics of the Ministry of Agriculture and Fisheries and of the Board of Agriculture for Scotland."

TABLE III.

Ratio of Agricultural and Industrial Production.

	Agricultural Production A.	Mineral Production B	Value added by Manufacture. C.	Ratio of A to B plus C.
	Millions of £'s.			
Australia (1925 26) .	250	21½	143	1 : 0·675
Canada (1926) . .	342	49½	280	1 · 0 96
Union of South Africa (1923 24)	67	55½	40¼	1 · 1·43
Great Britain (1924 25) .	274	230	1376	1 : 5 9

Sources of Information.

"Statesman's Yearbook, 1928."

"Canada Yearbook, 1926"

"Yearbook of the Union of South Africa, 1926 27."

"Agricultural Output of England and Wales, 1925 (Cmd. 2815)."

"Agricultural Output of Scotland, 1925 (Cmd. 3191)."

TABLE IV.

Extent to which agricultural output of the Empire is absorbed by the population of the producing countries.

	Agricultural Production.	Value of Agricultural Exports	Exports as percentages of Total Production.
	Millions of £'s.		
Australia (1925-26) . .	250	134	54
Canada (1925 26) . .	342	136	40
Union of South Africa (1923 24) . . .	67	24	36
Great Britain (1924-25) .	274	18 6	6·8

Sources of Information.

As for Table III, and "Statistical Abstract for the British Overseas Dominions and Protectorates (Cmd. 3198), 1928."

TABLE V.

Ratio of Agricultural to non-Agricultural exports.

	Agricultural Exports.	Total of all articles of domestic produce exported.	Percentage of Agricultural Exports to Total Exports.	Ratio. Agricultural.	Ratio. Non Agricultural
	Millions of £'s.				
New Zealand (1925) .	48 6	54 5	89	8·1	1
Australia (1925) .	134	159	84	5·25	1
Irish Free State (1925)	30 1	43 4	70	2 3	1
Canada (1926) . .	133·5	279·8	48	0 9	1
Union of South Africa (1925)	26·3	84·5	31	0·45	1
British India (1926) .	147·8	250·7	58	1 4	1
British Malaya (1925)	87 (Rubber only)	150	56	1·3	1
Great Britain and Northern Ireland .	18·6*	653	2·8	0 03	1

* Exports of home produced and of re-exported produce are not clearly distinguished.

Sources of Information.

"Statistical Abstract for the British Overseas Dominions and Protectorates (Cmd. 3198), 1928"

"Annual Statement of Trade of the United Kingdom, 1927."

TABLE VI.

DISTRIBUTION OF EXPORTS OF THE DOMINIONS AND COLONIES.

Millions of £'s.

Exported from Empire Countries to		
(a) Empire Countries.		
(1) United Kingdom	433·7	
(2) Overseas Dominions	141·0	(48½ per cent.)
(b) Foreign Countries	607 6	(51½ per cent.)
Total Exports to the World	1182·3	

TABLE VI—(*continued*).

DISTRIBUTION OF IMPORTS OF THE DOMINIONS AND COLONIES.

Imported into Empire Countries from	Millions of £'s.	
(a) Empire Countries.		
(1) United Kingdom	374·7	
(2) Overseas Dominions	147 6	(53 per cent.)
(b) Foreign Countries	462·7	(47 per cent.)
Total Imports from the World	985·0	

Source of Information.

"Statistical Abstract for the British Overseas Dominions and Protectorates (Cmd. 3198), 1928."

MANURING AND MAINTENANCE OF LOWLAND PASTURES.[1]

JOHN KIRKWOOD, B.Sc., N.D.A., N.D.D.,

Senior Lecturer on Agriculture, The West of Scotland Agricultural College, Glasgow.

THE most productive pastures (and by that is meant greatest stock carrying capacity—capacity to produce milk, beef or mutton) are not those in which wild white clover is most in evidence, but those where there is a nice admixture of grasses and clovers, but with grasses preponderating over the clovers.

We do not wish to belittle the value of wild white clover. It is a most valuable plant. But almost any virtue if carried to excess becomes a vice. One can have too much of a good thing, and one can have too much wild white clover in a pasture. We would further say that it is easier to establish a pasture with an excess of wild white clover, than one with a proper admixture of the better grasses and clovers.

Manuring.—To obtain maximum production from a pasture, manuring should begin during the rotation cropping. Assume an area of land is to be sown down to grass and that an ordinary rotation is being followed—green crop to clean the land, followed by oats or barley as a nurse crop. Assume also that a dressing of farmyard manure has been given to the green crop.

In the interests of the future pasture, a liberal dressing of a slow-acting phosphate should be given to the green crop and to the sow-out cereal crop—slag, ground mineral phosphate or steamed bone flour, whichever is thought to suit the type of soil best and taking into account the current price. A dressing of 6 cwt. slag should be given to the green crop. The following year with the sow-out cereal crop 4 cwt. slag should be given, i.e., a total of at least 10 cwt. slag in the two years or its equivalent in one of the other types of phosphate above

[1] Substance of Paper read at the Conference of County Organisers, Edinburgh, July 1929.

mentioned. With both crops, in addition to the slow-acting phosphate, about 2 cwt. superphosphate should be applied to bring the crop away. In both cases the total amount of phosphate applied should be more than may be considered necessary for the current season's crop.

On soils which require potassic manuring, the same procedure should be adopted with potash. Generally an application of 2 cwt. potash manure salts or the equivalent in some other form will be beneficial. It has now been well established by our soil chemists that these constituents—phosphate and potash—are firmly held in the soil, and not liable to be washed out with the drainage water.

Applied at these times the manure gets thoroughly incorporated with the soil, and a reserve of fertility is created to nourish and feed the young pasture plants during their development—the first summer, autumn and winter, and in the early years of the pasture. The foregoing is a sounder method than applying the same manures as a top dressing on the young seeds, or in two or three small dressings annually during the first years of the pasture, for it develops and establishes the grasses. The big grasses have deeper roots than wild white clover. Top dressings of slag at a later stage stimulate the surface creeping wild white clover more than the grasses.

A dressing of farmyard manure to the young seeds is beneficial. It has sometimes been suggested that such a practice has a detrimental effect on the quality of the pasture; but if the dung is properly spread we should certainly say it is beneficial. It ensures a steady supply of slow-acting organic nitrogen which will be gradually liberated. This gradual liberation of nitrogen from the dung is conducive to the establishment and maintenance of the good grasses. The dung also does good by acting as a mulch. Such treatment without further application of nitrogen will ensure a good first year's hay crop, and good pasture for some years. If dung has not been given, then a complete manure consisting of say 1 cwt. sulphate of ammonia, 2 cwt. superphosphate, 1 cwt. potash salts may be applied.

It is much more important with pasture than with crops to have a reserve of fertility. Crops only occupy the ground part of the year, and that during the warm growing season. Cultivation is given explicitly for their benefit. Pasture has to stand up to all weathers and to compete against weeds unaided by cultivation.

Lime.—In the establishment and maintenance of a pasture lime is a very important factor. Many of the disappointing results in attempting to establish a rotation pasture are due to the lack of this substance Numerous instances could be given. Space permits of a brief reference to two cases only.

At Overton Farm, Alexandria, Dumbartonshire, an experiment was put down in 1921. The lime was applied in the spring on the top of the ploughed stubble and was worked into the

soil during the preparation of the land for the green crop. On an area of 2 acres high quality ground lime was applied at the rate of 23 cwt. per acre. On another area of 2 acres, waste lime from a local calico works was applied. The waste lime was applied at such a rate per acre as ensured the same amount of lime (CaO) as was supplied by the ground lime. An area of 1 acre running parallel to and lying between these two areas was left unlimed. In the turnip crop the first year an increased yield of 3 tons per acre was obtained from both limed sections. The hay crop in 1923 unfortunately was not weighed, but the effect of liming was so marked in the aftermath that a demonstration was held. Red clover, the ryegrasses and other good grasses grew luxuriantly on both limed areas. On the intervening unlimed section only a sparse, wiry type of vegetation appeared. Some of the farmers present remarked that the unlimed area had the appearance of having been sown with inferior seed. On a visit to this field during the summer of 1928, the unlimed portion was still conspicuous, consisting of bent and a wiry type of vegetation which was coming into flower as a result of not being eaten. The adjacent limed areas consisted of the better grasses and wild white clover, which were being closely grazed by the dairy cows. On this farm during the past eight years, successful results have never been obtained in sowing land down to rotation pasture unless lime has been applied.

The West of Scotland College has a demonstration area at Hunterston, West Kilbride, Ayrshire. This was put through a course of cropping and sown down in 1925. In 1926 the hay crop on the limed portion weighed 45 cwt., on the unlimed 16 cwt. In the pasture in the seasons 1928 and 1929 clover and good grasses were thick and green on the limed portion while the unlimed is covered with bent, Yorkshire fog, sorrel and other weeds. These are extreme cases where a very pronounced lime deficiency existed. At Hunterston the pH value was 3·86, indicating a lime requirement of about 1 ton 13 cwt. shell lime. Many similar results, though not quite so pronounced, have come under our observation.

Lime encourages the good grasses. White clover is more tolerant of acid conditions than the good grasses. From our experience we are inclined to think that top dressings of phosphate encourage clovers at the expense of grasses.

Dr. Winifred Brenchley in the course of her work has established the fact that an application of lime to pasture land was followed by a reduction in the amount of bent. But on rotation pasture, if lime is applied prior to the sowing of the grass seed, bent will never become established to the same extent. When sowing land down to grass, see that the lime requirement is satisfied. Then apply sufficient manure to bring up the fertility; in other words ensure that the grasses are properly fed. If this is done a good type of vegetation will be established and the inferior type of pasture plants—bent, &c., will not be much in evidence.

Maintenance.—The treatment already prescribed should maintain a good pasture for three to five years, provided skill is exercised in the grazing and management. (See details of farm 1 later.) After this, periodic applications of artificials should be given to maintain production, say 5 or 6 cwt. of slag or 3 cwt. ground mineral phosphate every third or fourth year. Potash also should be given if the soil is of the type that requires it. Up to 1 cwt. of one of the nitrogenous manures applied annually will be beneficial to the grasses. (The question of intensive manuring of grassland is outwith the scope of this paper.)

Seldom is any farmyard manure available for pasture, the whole supply being required for green crop, forage crops and hay. If available, however, it is beneficial to established pasture. It is sometimes held that farmyard manure encourages coarse, inferior plants. We do not think so. The reason for that belief is that dung is often applied to pasture at the wrong season. If applied in late winter or spring the resulting pasture seems to be unpalatable. Stock—especially cattle—will not eat it. And any pasture not eaten soon coarsens and deteriorates. To pasture dung should be applied in late summer or autumn, at the latest before the end of December. Applied thus the unpalatableness seems to have disappeared before the growing season and stock eat down the treated pastures greedily the following spring and summer. The dung helps to retain the good grasses. Where farmyard manure has been applied to pasture there should be no need of nitrogenous manuring for two or three years.

Management.—The young seeds should not be grazed the first winter, i.e., after the cereal crop has been removed. We know of no more short-sighted policy than the all too common one of allowing sheep, often hoggs that are taken in to winter, to run on the young seeds from October to April. The rooting system is not fully developed at this time, and if every blade or shoot is nibbled as it appears, there is no doubt that some plants are killed and all are weakened. There are cases in which, with an early harvest and mild autumn, the young grass grows very luxuriant or "proud." In such cases it may be beneficial to top it—graze it for two or three weeks. Similarly in spring if it is very luxuriant, top it, but do not allow sheep to run over it the whole winter. In most cases, however, it should not be grazed at all. Professor Stapledon has proved this experimentally, but from our own observations under ordinary field conditions we have no hesitation in saying that it is bad economy to graze young seeds the first winter.

Under ordinary conditions mowing is preferable to grazing in the first year. This allows the pasture plants to get thoroughly established and is conducive to strong root development. Grazing the first year has been advocated on the grounds that it conserves fertility. But fertility removed in the hay crop can be made good by the application of manures, or rather, as already advocated in this paper, should have been provided for in the previous treatment of the land. The hay crop should be cut as soon as the

"flower" has disappeared. If left after this stage, seed formation begins which has an exhausting and weakening effect on the plants.

Where hay has to be taken the first year, the quantity of ryegrasses, perennial and Italian, in the mixture should be restricted. These plants, particularly the latter, cover the ground quickly and reach maturity early, and if sown in large amounts will crowd out or at least hamper the other slower maturing but more lasting ingredients in the mixture. About 8 lbs. perennial and 4 lbs. Italian per acre, or where Italian is not included, 12 lbs. perennial should seldom be exceeded. If the young seeds are to be grazed the first year, larger amounts of the ryegrasses may be used, as under grazing conditions these plants do not have the chance of shading or crowding out the other plants of the mixture.

Rotational grazing is beneficial. Where a field carries stock every day throughout the grazing season, certain areas—the sweeter and more palatable and even special plants—will be constantly grazed very closely. This continued over a number of years must ultimately weaken or actually kill out certain good grasses. If rotational grazing is practised—if the pasture is hained for three or four week-spells, periodically throughout the grazing season—then the much depastured grasses have an opportunity to recuperate and re-establish themselves. It will be found that the big productive grasses prove more permanent under such treatment. Another advantage is that stock graze more evenly. After a rest period the whole area seems to be more uniformly palatable. Where grazing is continuous certain patches are left untouched and these soon develop into coarse, inferior herbage. We do not suggest that fields should be subdivided for this purpose. The ordinary fields or separate enclosures on a farm can often be made the basis of rotational grazing without the expense of further sub-division.

Droppings should be scattered. This may be done by harrowing, but is more effectively done by manual labour, a four-pronged graip being used. Scattering of droppings is more important on good land than on second-rate land. If this is not done on land capable of carrying a dairy cow or a fattening bullock per acre, then by the end of the season, a very considerable proportion of the area will be covered by droppings, and surrounding these there arises a rank coarse herbage, untouched by stock. Where attention is paid to this point, more uniform herbage and more uniform grazing results. The cumulative improvement where the droppings have been scattered for a number of years is very great. If as a result of understocking, grass plants are coming into ear then the mowing machine should be run over them. This is more often necessary where land is being grazed by sheep than by cattle.

In the following tables the results obtained at two farms where the general treatment and management above outlined have been substantially followed are set out. In one column is

given the actual percentage botanical compositions of the fields from an analysis made in July 1929. In a second column is given in pounds the grass seed mixture sown per acre. In the analysis both meadow and tall fescue are included as meadow fescue, and both rough and smooth stalked meadow grass as rough stalked. In both cases the first mentioned plants—meadow fescue and rough stalked meadow grass—were by far the more prominent.

Farm 1.—A high lying dairy farm in Lanarkshire. Altitude 800 feet. Soil, a loam. Rotation, lea oats, green crop, chiefly turnips, sow-out oats, hay followed by seven or eight years pasture. Manurial treatment :—Turnips received a dressing per acre of 12 tons farmyard manure, 2 cwt. superphosphate, 3 cwt. steamed bone flour, 1 cwt. potash manure salts. Sow-out oats, 1 cwt. supers., 1 cwt. steamed bone flour, 1 cwt. ground mineral phosphate, ¾ cwt. muriate of potash, ½ cwt. sulphate of ammonia. Hay crop, 10 tons farmyard manure applied between the beginning of January and the end of March. Lime is given at some stage during the rotation, the quantity varying from 2 tons shell lime applied to field D, down to 10 cwt. ground limestone to field A.

FIELD A.

Grass Seed sown 1926.

Name	*Botanical Composition 1929.*	*Seed Mixture in pounds per acre.*
Perennial Ryegrass	25 per cent.	10
Meadow Fescue	20 ,,	8
Cocksfoot	11 ,,	7
Timothy	9 ,,	4
Yorkshire Fog	6 ,,	–
Crested Dogstail	4 ,,	–
Meadow Foxtail	3 ,,	2½
Rough Stalked Meadow Grass	2 ,,	–
White Clover	14 ,,	¾
Red and Alsyke Clover	3 ,,	3½
Daisies, Buttercups and other weeds	3 ,,	–

In addition to the general manurial treatment stated above, this field was given a dressing of 10 cwt. of slag a few days before the grass seeds were sown. This special treatment was adopted in order to establish a first-class pasture, and so avoid as long as possible the necessity for ploughing up the field again, as it is very steep and awkward to cultivate.

This field has been the subject of much comment in the district for the excellence of its pasture.

FIELD B.

Grass Seed sown 1925—Third year pasture.

Name.	*Botanical Composition 1929.*	*Seed Mixture in pounds per acre.*
Rough Stalked Meadow Grass	15 per cent.	½
Timothy	12 ,,	4
Crested Dogstail	10 ,,	–
Cocksfoot	9 ,,	8
Meadow Fescue ... ... } Tall Fescue ... .. }	7 ,,	4
Perennial Ryegrass ..	7 ,,	10
Yorkshire Fog	5 ,,	–
Bent	5 ,,	–
Meadow Foxtail	4 ,,	2
White Clover (Wild) ...	15 ,,	¾
Annual Meadow Grass ...	3 ,,	–
Daisies, Buttercups, Lady's Mantle, &c., including some Red Clover ...	8 ,,	–
Red and Alsyke Clover ...	–	4½

FIELD C

Grass Seed sown 1924—Fourth year pasture.

Name	*Botanical Composition 1929*	*Seed Mixture in pounds per acre.*
Rough Stalked Meadow Grass	14 per cent.	1
Crested Dogstail	13 ,,	–
Meadow Fescue	9 ,,	4
Timothy	9 ,,	4
Yorkshire Fog	6 ,,	–
Perennial Ryegrass	5 ,,	10
Cocksfoot	5 ,,	8
Meadow Foxtail	4 ,,	2
Annual Meadow Grass ...	3 ,,	–
Bent	2 ,,	–
Wild White Clover	21 ,,	1
Daisies, Buttercups, &c. ...	9 ,,	–
Red and Alsyke Clover ...	–	4½

FIELD D.

Grass Seed sown 1921—*Seventh year pasture.*

Name.	*Botanical Composition 1929.*	*Seed Mixture in pounds per acre.*
Crested Dogstail	18 per cent.	–
Rough Stalked Meadow Grass	14 ,,	½
Meadow Fescue	13 ,,	5
Tall Fescue		3
Yorkshire Fog	9 ,,	–
Meadow Foxtail	4 ,,	3
Perennial Ryegrass	4 ,,	7
Italian Ryegrass	–	4
Timothy	4 ,,	4
Cocksfoot	3 ,,	7
Annual Meadow Grass ...	2 ,,	–
Bent	2 ,,	–
Wild White Clover	18 ,,	1½
Daisies, Buttercups and other plants	9 ,,	–
Red and Alsyke Clover ...	–	4

FIELD E.

Grass seed sown 1910, *hay taken for three years, i.e.*, 1911, 1912, 1913—*now in its sixteenth year of pasture.*

Name.	*Botanical Composition 1929.*	*Seed Mixture in pounds per acre.*
Crested Dogstail	22 per cent.	–
Meadow Fescue	13 ,,	5
Tall Fescue		4
Meadow Foxtail	8 ,,	2
Rough Stalked Meadow Grass	8 ,,	–
Yorkshire Fog	8 ,,	–
Timothy	6 ,,	8
Bent	5 ,,	–
White Clover	15 ,,	1
Buttercups, Daisies, &c. .	15 ,,	–
Italian Ryegrass	–	6
Cocksfoot	–	4
Tall Oat Grass	–	4
Red Clover	–	3

Farmyard manure was applied to the hay crop in 1911 and again in 1912. To the 1913 hay crop a dressing of 1 cwt. nitrate of soda was given. No other manurial treatment until 1921 when 10 cwt. basic slag was applied. No manurial treatment since.

chief ingredients in the third year's hay crop (1913) were timothy, cocksfoot, meadow and tall fescue. From the botanical analysis made in 1929 it will be seen that cocksfoot has entirely disappeared, while meadow and tall fescue still persist to the extent of 13 per cent. This field has always been very closely grazed during winter and spring by the milk cows which have been turned into it for water and exercise daily.

From the botanical analysis given, it will be seen that all of the fields are maintaining a first class type of vegetation. All of them yielded a hay crop of from 3 to 4 tons the first season. All of them have been carrying a cow per acre during the grazing season, and in addition are grazed in the winter by young cattle, and for a few weeks in spring by ewes and lambs.

Field A for the seasons 1928 and 1929 has carried stock equivalent to 1½ cows per acre.

Farm 2.—Situated in the Barrhead district of Renfrewshire. A field after being put through the usual rotation was sown down to grass with a nurse crop of oats in 1924. No farmyard manure was applied to the young grass, but a complete manure consisting of sulphate of ammonia, superphosphate and potash was given. A very heavy hay crop was cut in 1925. A dressing of artificials consisting of 1 cwt. sulphate of ammonia, 1 cwt. superphosphate, ½ cwt. steamed bone flour, ½ cwt. potash manure salts has been given each spring to the pasture. For the four seasons, 1926 to 1929 inclusive, the field has grazed exceptionally well, carrying an average stock of 1¾ dry cows and in-calf heifers per acre. The cows have either been back calvers or cast cows being fattened for the butcher. No concentrates have been given.

When the field was sown down it was decided to try 1 acre with a preponderance of cocksfoot—14 lbs. per acre, the remainder of the field being sown with what is hereinafter described as the "normal" mixture.

NORMAL MIXTURE.

Name.	*Botanical Composition 1929*	*Seed Mixture in pounds per acre.*
Yorkshire Fog	19 per cent.	–
Crested Dogstail	15 ,,	–
Meadow Fescue	12 ,, (Meadow and Tall Fescue together)	5
Tall Fescue		4
Perennial Ryegrass ...	12 ,,	9
Timothy	7 ,,	4
Cocksfoot	5 ,,	8
Rough and Smooth Stalked Meadow Grass ...	2 ,,	1
Wild White Clover ...	19 ,,	1
Red and Alsyke Clover ...	A few plants.	4
Buttercup	5 per cent.	–
Ragweed	2 ,,	-
Annual Meadow Grass ...	2 ,,	–

COCKSFOOT MIXTURE.

Name.	*Botanical Composition 1929.*	*Seed Mixture in pounds per acre.*
Yorkshire Fog	23 per cent.	–
Crested Dogstail	17 ,,	–
Perennial Ryegrass... ..	14 ,,	12
Italian Ryegrass	–	6
Cocksfoot	8 ,,	14
Timothy	8 ,,	4
Wild White Clover ..	18 ,,	1
Red Clover and Alsyke ..	A few plants.	3
Annual Meadow Grass ...	3 per cent.	–
Buttercups	6 ,,	–
Ragweed	3 ,,	–

Both in the first year's hay crop and each year since, the cocksfoot plot appeared to be less productive than the remainder of the field sown with the normal mixture. From the analysis given it will be seen that in the fourth grazing season, despite the heavy seeding, cocksfoot only represents 8 per cent.

A noteworthy point in all of the analyses given above (for both farms) is the small amount of bent, annual meadow grass and other inferior plants.

In none of the fields referred to was any stock ever allowed on the young seeds until after the first year's hay crop had been removed. On Farm 2, the pasture does not carry any kind of stock for five months from November to April.

Farm 3.—To illustrate the disappointing results that may be obtained where good grass seed mixtures are used, but where the feeding or manurial treatment of the soil has been deficient, the following case which came under our observation is given.

Six acres at one end of a large field, which was known to have been under grass for over twenty years, was ploughed in 1921. In order to rot the very thick "mat" or turf present, three successive oat crops were taken, followed by potatoes in 1924. A grass seed mixture was sown with a covering crop of oats in 1925. Hay was cut in 1926. The field has been grazed by dairy cows since. A ten ton dressing of farmyard manure was applied to the potato crop. The cereal crops and the hay received a cast of a compound manure consisting chiefly of superphosphate and sulphate of ammonia. Quite satisfactory crops of oats and potatoes were obtained. The hay crop, however, was light. Undernoted is the seed mixture used and the botanical composition of the pasture in July 1929.

Name.	Botanical Composition 1929.	Seed Mixture in pounds per acre.
Bent	36 per cent.	–
Sheep sorrel	24 ,,	–
Perennial Ryegrass	12 ,,	6½
Sweet Vernal	10 ,,	–
Hard Fescue	2 ,,	2
Miscellaneous	16 ,,	–
Italian Ryegrass	–	6½
Timothy	–	2
Cocksfoot	–	6
Meadow Fescue	–	4
Tall Fescue	–	2
Tall Oat Grass	–	6
Red Clover and Alsyke Clover	–	3¾
Ordinary White Clover ...	–	1¼

From the botanical composition given above, it will be seen that of the seed sown only perennial ryegrass and hard fescue are present in the third year's pasture. The grass seeds were obtained from one of the best known and most reputable firms in Britain. The sward is thin and there is practically a complete absence of clover. The fact that the "mat" required three crops of oats to rot it, and the composition of the present pasture show the clamant need of lime. There could be no hope of success without liming. In addition, the land had been impoverished by the six successive crops carted off. On another part of the same field, which has not been broken up, an experiment with slag and potash is being tried. This is bringing up the white clover. Had lime and a liberal dressing of phosphate been applied before sowing the grass seeds, the results would have been quite different.

It is outwith the scope of this paper to deal with grass seed mixtures but there is one point that we feel constrained to touch on—that meadow and tall fescue are worthy of more consideration than is given them at the present time. If one studies the grass seed mixtures that are recommended by most of our Universities, Agricultural Colleges and Farm Institutes, the large fescues are conspicuous by their absence. In recent years there has been a tendency to adopt what are sometimes called simple mixtures, the basic components of which are perennial ryegrass, cocksfoot, timothy, red and white clover. For good loams and heavier types of soil in the south-west of Scotland, particularly in the counties of Dumbarton, Renfrew, Ayr and Lanark, meadow fescue and rough stalked meadow grass are of as great importance. The average rainfall in this area may be taken at about 40 inches, and this fairly heavy rainfall is undoubtedly an environmental condition favourable to the two plants mentioned. Once established, meadow fescue will prove a more permanent grass than either cocksfoot or timothy. For its establishment two factors are essential. First, that the amount of perennial and Italian ryegrass in the mixture be kept restricted. Secondly,

that it be sown in sufficient quantity—8 lbs. or more per acre. It is little use sowing 2 or 3 lbs. in a mixture consisting chiefly of the aggressive, quick growing grasses.

Cocksfoot, on the other hand, has perhaps at present a popularity beyond its real value. If four, five or six year old pastures are examined, where 8 or 9 lbs. have been included in the seed mixture, not very much cocksfoot is in evidence. Further, cocksfoot is much more liable to winterburn than meadow fescue.

Our conclusion then is that for good loams and the heavier types of soil, meadow fescue could with advantage be included in mixtures where the land is to be under grass for four or more years. Under these conditions and provided the rain-fall approximates about 40 inches, it is likely to be a more permanent and more productive pasture plant than cocksfoot. A study of the analyses given for the fields on Farms 1 and 2 will bear this out.

Summary.— For the establishment and maintenance of a good lowland pasture the following points are important :—

1. Correct the lime requirement by the application of lime prior to the sowing of the grass seed.
2. Build up a reserve of fertility prior to sowing the grass seeds by liberal applications of minerals, particularly of slow acting phosphates such as slag, mineral phosphate or steamed bone flour.
3. If available give farmyard manure to the young seeds. This ensures a continuous supply in the earlier years of slow acting nitrogen. This especially benefits the big productive grasses.
4. Mowing is preferable to grazing the first year.
5. Keep the grasses in a pasture from running to seed even if the mower has to be used.
6. For the better types of soil, meadow fescue is worthy of inclusion in a seed mixture.

The suggestions made are all with a view to establishing and maintaining the good productive grasses as well as clover and of having a proper admixture of grasses and clovers. There is a tendency to point to pastures which are green with wild white clover as being first class. Undoubtedly they are. But many such pastures could be made more productive if a larger proportion of grasses were present, and with this the risk of "hoven" in cattle, which has been causing a good deal of trouble in some localities, will be very much reduced.

Although in this paper the treatment given to, and the botanical composition of, a few specific pasture fields are stated, these cases merely bear out or are illustrative of the observations made and beliefs formed during a very considerable number of years' work in the south-west of Scotland.

The writer desires to express his gratitude to his colleague Mr. W. F. Burnett, M.A., B.Sc., Lecturer on Botany in the West of Scotland Agricultural College, for so kindly carrying out the botanical analysis.

SOME ECONOMIC ASPECTS OF NEW ZEALAND DAIRY-FARMING.

JORIAN E. F. JENKS, N.D.A.

SURPRISE is often expressed at the high price that the New Zealand dairy farmer is prepared to pay for his land. A few years ago £80, and even £100, an acre was being paid for high-class farms; and though the average price then obtained was much below these figures, and is now lower still, it is remarkably high when taken in conjunction with the fact that the price the farmer receives for his produce is, on the whole, decidedly less than that current either in Europe or America.

The explanation is to be found partly in the comparative scarcity of first-class land in New Zealand, but mainly in a farming system which has practically reduced dairying to a well tested formula, and working costs to a point at which further economies seem impossible. The main features of this system are comparatively simple :—

(*a*) Persistent concentration on the particular product for which the land is best suited.

(*b*) Maximum utilisation of permanent pasture, and of the long grazing-season which the equable climate permits.

(*c*) Exploitation of the reproductive capacity of the cow, so that the period of maximum milk-secretion is timed to coincide with the period of maximum grass-production.

(*d*) Intensive use of machinery in order to obtain comparative independence of hired labour.

(*e*) A factory system that enables the farmer to give the whole of his energies to milk production.

The manufacturing side of New Zealand dairying is too big a subject for the scope of this article, but it should not be overlooked that the co-operative factory, to which the farmer was originally driven by lack of other outlets, is now one of the strongest, as well as one of the most vital links in the chain of production. The number of suppliers per factory is exceptionally high, and is rising still further as smaller units are closed down, so that overhead charges and operating costs per lb. of produce are kept very low indeed.[1]

The butter-factories collect by motor-lorry, waggon, or river-launch from wide areas, usually taking home-separated cream from the farmer's own gate; all cream is tested and graded, and payment is made on a butter-fat basis. The factories producing cheese, casein, or milk-powder, are situated in districts so intensely utilised for dairying that there are thousands of cows within a few miles and the milk need be transported only a short distance. These factories also pay on a butter-fat basis.

[1] One co operative company operating 60 factories has approximately 8,000 suppliers with 300,000 cows, an average of 133 suppliers with 5,000 cows per factory.

Statistical Data.—The economic significance of the methods adopted on the farms is well brought out by a study of the official yearly agricultural and pastoral returns. The returns of 1926-27 are taken as the basis of this article.[1]

Since dairying is in New Zealand a specialised type of farming rather than a department of mixed husbandry, the section of the returns which refers to "holdings used principally for dairying" may be taken as representative of the industry. Actually these holdings maintain 1,064,987 out of a total of 1,280,212 dairy-cows in the Dominion, or 83 per cent. But in order to obtain a clearer picture of the typical commercial farm, the writer has thought it best to omit holdings of under 41 acres and holdings of over 2,000 acres. The former class average less than 6 cows per farm, and 38 per cent. are returned as having no "employees,"[2] so that there is a strong presumption that the majority of them are either part-time occupation or are used simply for the supply of household milk. The latter class number only 82, and in all probability have too high a proportion of land that is either unproductive or is used for other purposes to permit of their inclusion as representative dairy-farms.

Since the type of dairy-farm and the general methods employed are fairly uniform throughout the Dominion, an average derived from these returns (with the omissions noted above) will give a reasonably accurate idea of the typical dairy-farm (as at January 31st, 1927).

Total acreage		200	Cows[3]	37
Acres "cultivated"		12	Other cattle	20
Employees:—			Horses	3·7
Male	1·6		Pigs	14
Female	0·6		Shorn sheep	37
Total		2·2	Lambs	27

Several important deductions may be made from these figures; the following points should be noted:—

(*a*) Since "cultivated" land includes all crops, hay, lucerne and newly-sown grass, permanent pasture is of overwhelming importance as a source of feed.

(*b*) Concentration on milk-production is the rule, neither pigs nor sheep being well represented on this type of farm.

(*c*) As it is the customary practice for dairy-farmers to rear their own heifers, and to bring them into the milking-herd at two years old, the majority of the "other cattle" will be for herd-maintenance rather than for sale. (Fattening is rare on dairy-farms, and male calves are seldom reared.)

(*d*) The number of horses is unavoidably high in proportion to the amount of cultivation; but they are maintained cheaply on grass, and actually a fair number will be hacks and children's school-ponies.

[1] Statistical Report on Agricultural and Pastoral Production, 1926–27. Government Printer, Wellington New Zealand

[2] "Employees" includes the farmer and all working members of his family.

[3] "Cows" includes all cows and heifers used for dairying and over two years old at mid-summer.

(e) The typical farm is run by the farmer himself, with the assistance of either one male employee or his wife or daughter (hired female labour is rare).

Financial Estimate for Average Farm.—To arrive at the earnings of these holdings it is necessary to make estimates of certain items. Minor items are relatively constant, but the two main factors are the price paid for the land and improvements, and the price received for butter-fat; and these have shown considerable fluctuations during the last ten or twelve years.

Land-values in particular are hard to estimate, since they have hardly regained the stability they lost during the post-war "boom" and resulting "slump," and sales have not been numerous in recent years. Dairying is moreover carried on on many different types of land, ranging from poor hill-sides worth £5 an acre to rich river-flats worth £70 or £80. The consensus of expert opinion is that £75 per cow is a fair value for an average improved farm, so that the 37-cow holding under review can be capitalised at £2,775, plus 20 per cent. for other cattle and sheep. The total capital invested in land, buildings, &c., on the average farm is therefore £3,335.

Live stock, on the other hand, are comparatively cheap. Useful cows are worth about £8 each, ewes 30*s*. to 35*s*., horses of the type used on dairy-farms anything from £5 to £35. Stock and plant can therefore be put at the following values: 37 cows £296, other cattle £70, horses £45, sheep £55, pigs £20; milking-plant (machines, separator and engine) £125, mower, rake, plough, fertiliser-distributor, and minor implements £75; total £686.

The total capitalisation of the farm, stock and equipment stands then at £4,016, or say £4,000 for the average farm. Interest on this can hardly be put at less than 7 per cent. A good deal of money outstanding on New Zealand farms represents State loans at 5½ per cent., but even more represents private loans and mortgages at 6 to 7½ per cent., while 8 per cent. and upwards is expected for live stock and temporary accommodation. The annual interest on the average farm is thus £280, of which approximately £233 is for the farm itself; 23*s*. an acre is no small rent when the prices obtainable for produce are taken into consideration.

Upkeep of buildings, depreciation and replacement of machinery and implements, petrol for the engine, rubbers for milking-machine, &c., will be fully £60 a year. General charges, such as local rates, and insurance premiums, amount to another £30. The land itself will need 15*s*. an acre annually for fertilisers, seed, fencing materials, &c., and the live stock £20 for bulls, rams, service fees, &c.; no depreciation is charged, the assumption being that replacements are made from home-reared young stock. Outlay on purchased foods is seldom significant, so that the annual outgoings, apart from interest and wages, will amount to £260.

The income will depend mainly on receipts from the factory. Monthly payments are made for butter-fat (usually up to 90 per cent. of its current value), and there is a bonus at the end of the season. The average return (including bonus) at the present time is put by several authorities at 1*s.* 4*d.* a lb.; this is a fair estimate if market fluctuations are taken into consideration. The average yield per cow is approximately 200 lbs. of butter-fat per annum, and its value £13, 6*s.* 8*d.* This rather low figure is due partly to the fact that almost every herd includes a few cows which for some reason or other are temporarily unproductive and partly to the seasonal milking, all cows being timed to calve in spring (August-September) and dried off in late autumn (May-June) after nine or ten months milking.

Fourteen pigs per farm at mid-summer (see previous data) will mean approximately twenty turned off during the season.[1] The bacon factory weight is 160 lbs. (dead), and with current prices in the vicinity of 5*d.* a lb., this means £80 from this source of income. Other receipts will be £30 for cull cows and surplus heifers, and £10 for hides and calf-skins. The sheep should bring in about £60 a year in wool and lambs. Table I shows the above calculation in the form of a profit and loss account:—

TABLE I.

Estimated Profit and Loss Account for Average Farm.

Outgoings.		Receipts.	
Interest on land, stock and plant at 7 per cent.	£280	7,400 lbs. butter-fat at 1*s.* 4*d.*	£493
Upkeep of machinery, &c.	60	20 pigs at £4	80
General charges	30	Cattle sold	30
Fertiliser, seed, &c.	150	Hides and skins	10
Stock expenses	20	Sheep receipts	60
Labour income	133		
	£673		£673

Per Cow.		Per Employee.	
Capital	£108 2 2	Gross receipts	£305 18 2
Gross receipts	18 3 9	Labour income	60 11 10
Interest on capital	7 11 4		
Working expenses	7 0 6		
Labour income	3 11 11		

Financial Data from two Districts Compared.—As yet, very little agricultural economic data are available for New Zealand, but Mr. E. J. Fawcett, of the Fields Division of the Department of Agriculture, carried out surveys of two dairying districts for the 1926-27 season.[2] His data are very valuable for comparison with the estimates given above.

(a) *Raglan.*—Both districts are in the Auckland province, which is now well in the lead for dairying production. One, Raglan, is a west-coast county with a rather fertile semi-volcanic,

[1] The number of pigs is regulated by the supply of skim milk or whey, very little purchased food being used.

[2] *Journal of the Department of Agriculture*, Wellington, New Zealand, August and October 1927.

soil and well-distributed rainfall; in many ways it is very typical of many New Zealand dairying districts. The following tables show how the Raglan farms surveyed by Fawcett compare financially with the previously estimated average for the Dominion.

TABLE II.

Financial Data for Raglan District compared with Dominion Estimate.

	Raglan.		Estimated Average for Dominion.	
	Per farm.	Per 100 acres.	Per farm.	Per 100 acres.
Average acreage	173	...	200	...
Number of cows	40	23	37	18·5
Receipts—	£	£	£	£
Butter-fat at 1s. 4d. per lb.	503	291	473	236
Pigs	50	29	80	40
Total .	597	345	673	336
Total capital	3,165	1,830	4,000	2,000
Interest at 7 per cent. ..	222	132	280	140
Working expenses	228	128	260	130
Labour income	147	84	133	66

Per Cow.	Raglan.	Dominion
Lbs. of butter-fat per ann.	193	200
Gross receipts	£14 18 6	£18 3 9
Capital invested ...	80 0 0	108 0 0
Labour income	3 13 1	3 11 11

The Raglan figures thus provide a rather interesting confirmation of those derived from the estimate for the Dominion as a whole. The only divergencies of any moment occur in the proportion of butter-fat to other sources of income in the gross receipts, and in the capital valuation (Fawcett takes the Government valuation for the land, which is slightly conservative). The small remuneration left to the farmer and his employees is very evident.

(b) *Piako.*—The other district, Piako, lies to the south of the Hauraki Gulf, and has a climate rather similar to that of Raglan. The land, however, is mainly drained swamp of high natural fertility and market value. The farming, too, has reached a degree of intensity well above the average for the country as a whole. In this case, Fawcett makes no reference to the size of the farms save that they are between 50 and 300 acres.

TABLE III.

Financial Data for Piako District compared with Dominion Estimate.

Per 100 Acres.	Piako.	Dominion.
Number of cows	42	18·5
Receipts—	£	£
Butter-fat at 1s. 4d. per lb.	815	236
Pigs...	50	40
Total	907	336
Total capital	3,264	2,000
Interest at 7 per cent	230	140
Working expenses	221	130
Labour income	466	66
Per Cow.	**Piako.**	**Dominion.**
Lbs. of butter-fat per annum	291	200
Gross receipts	£21 11 11	£18 3 9
Capital invested	77 0 0	108 0 0
Labour income	11 19 1	3 11 11

The Piako figures show very clearly, firstly, how really good land may be worth to the farmer considerably more than the high value put on it in comparison with land of less natural productivity. It is certainly doubtful whether a typical Piako farm could be bought and stocked, even to-day, for £32 an acre, but the capital value could be a great deal higher before the labour income was reduced to the Dominion standard. Assuming for the moment that interest must be paid on all capital, £12 a cow for wages means prosperity, while £3, 12*s*. a cow is a bare living, unless the herd is comparatively large.

The second point is that where fixed charges (such as interest) are high, intensification is frequently profitable, for the excellent results obtained by the Piako men are due, not only to the natural fertility of their land, but to their methods. An average of 291 lbs. of fat per cow is extremely good, even for first-class land. The average expenditure on fertilisers, for instance, is nearly £1 an acre per annum, a high figure for almost any country. Fertility and intensification together have enabled them to stock so heavily that although their capitalisation per acre is far above the average, their capital per cow is actually less.

Conclusions.—1. It is clear that the capital value of New Zealand dairy farms is, comparatively speaking, so high that interest on it amounts to nearly half the cost of production. As a large proportion of agricultural capital is borrowed, this is a very important factor. An extensive system of credit, easy

land-transfer, and a limited supply of land, lead inevitably to speculation at fictitious values during "boom" periods. It is said that during the 1918-21 boom certain farms in favoured districts were loaded to the extent of as many as twelve mortgages as the result of a long sequence of transfers.

Rural mortgages registered during the last ten years amount to £197,383,000, the peak occurring in 1921, when nearly 40 million pounds was registered. Naturally the recent period of deflation has seen a good deal of "writing down" to values more nearly approaching reality. It is difficult to see how the easy credit that is so essential in a young and growing country can be safeguarded either against speculation or against legitimate but abnormal land-development costs, during periods when price levels are rapidly changing.

2. This high capitalisation is to some extent justified (as in the case of the Piako farms) by the extent to which permanent pasture can be relied upon for milk-production, with little or no resort to fodder crops or concentrated foods. Working expenses are thus kept very low.

3. The average labour income is so low that, even if due allowance is made for house-rent and farm-grown food, there is small margin for hired labour. Even the semi-skilled lad that so many dairy-farmers employ costs 25*s.* a week plus board and lodging, so that the farmer must use his own energies to the best advantage.

Men with large farms, or with more than one herd, usually find a solution in the employment of share-milkers, often men with large families of working age, who undertake all the work in return for a third of the factory cheques and half the pigs and calves.

High output per man is the key-note of New Zealand dairy-farming as opposed to high output per acre. It is, thanks to this, and to a considerable amount of unpaid family labour, that the farmer is enabled to make a living at all. It is usually accepted that not less than 25 cows are needed to provide a living for one man and his dependants.

4. Since the greater part of his outgoings (interest, rates, upkeep of machinery, &c.) are comparatively constant, it is apparent that any intensification of methods which does not call for much extra labour is likely to increase the net income. A good instance of this is to be found in the manuring of the pastures, which respond remarkably to phosphates, and again in the improvement of the herds by record-keeping (with butter-fat tests) and more systematic breeding. As New Zealand has ample supplies of phosphate rock in Nauru Island for conversion into superphosphate, and has also abundant stocks of pedigree dairy-cattle of good type, there seems to be little doubt that her dairy-farmers will seek to solve their economic difficulties by increasing their already notable export of dairy-products.

The writer wishes to acknowledge his indebtedness to Messrs. C. S. Orwin and A. Bridges of the Agricultural Economics Research Institute, Oxford University, for much valuable guidance in the assembling of the material for this article.

AN ACIDITY SURVEY OF TWO PARISHES IN THE WEST OF SCOTLAND.

CHARLES LOUDEN, B.Sc., A.I.C.

West of Scotland Agricultural College.

THERE is presented here a summary, in a simplified form and without detailed statistics, of a report presented to the Department of Agriculture for Scotland. The work described forms an appendix to an agricultural survey of certain parishes carried out by the Department, and published in this JOURNAL, April 1928, vol. xi, page 157. The acidity survey, undertaken by the late Professor Berry, was made in the late spring and the summer of 1928, the field work being done by the writer and Mr. Ian Mowat, B.Sc., A.I.C., while Mr. Edward Melville, M.A., B.Sc., A.I.C., was responsible for all the laboratory determinations.

Methods.—(a) *In the Field.*—A composite sample of the upper soil layer was taken in every field, or oftener in large fields or where the Soiltex test (described later) or vegetation differences indicated a variation in acidity. After the removal of a piece of turf, a sample of soil was taken 2 inches to 7 inches deep, and two or three such samples from one field (or part of a field) were mixed to form the composite sample. Subsoil samples were also taken, wherever this could conveniently be done, from depths below 9 inches, or as indicated by a change in the soil. Many samples were taken from moorland, but this was not studied so closely as the cultivated land. In addition, samples were taken from woodlands, which have a fairly large total acreage in one of the parishes; these, however, are not discussed now. During the work notes were made on the soils, profiles, state of crops, weeds, drainage, and so on.

(b) *In the Laboratory.*—The soil samples, after a suitable preparation, were examined by electrical methods which gave an accurate measure of the acidity in terms of certain rather abstruse but fundamental units. Certain simple acidity tests were also carried out, alongside this reliable one, for purposes of comparison.

Presentation of Results.—(1) Maps, on the scale of 6 inches to 1 mile, were coloured to show the varying degrees of acidity in the different plots, so that any general geographical or geological grouping might be manifested; but, although certain tendencies of this kind were shown, they were much obscured by field-to-field variations, due to differences in the history of individual fields, so that statistical treatment was found to be the most satisfactory method of presenting the results.

(2) Tables and diagrams were drawn up showing how many acres, and what proportion of the total acreages, gave certain degrees of acidity. For simplicity, these are presented here

in a modified form, and, to facilitate comparison, Dr. Ogg's grouping and descriptions are adhered to, viz. :—

Class.	Description of Reaction.	pH Value.
1.	Alkaline.	7·50 and over
2.	Do.	7·00–7 49
3.	Slightly acid.	6 50–6·99
4.	Fairly acid.	6·00–6·49
5.	Acid.	5·50–5 99
6.	Strongly acid.	5 00–5 49
7.	Very strongly acid.	4 50–4 99
8.	Abnormally acid	4 00–4·49
9.	Do.	3 50–3 99

(See Ogg and Dow: "An Acidity Survey of Two Parishes in Berwickshire," *Scottish Journal of Agriculture*, July 1928, vol. xi, page 273.)

It is to be understood, of course, that the descriptions applied to the different ranges of acidity in the above table were not intended to be anything more than convenient labels, for which no scientific accuracy has been claimed. pH values, on the other hand, give a precise measure of something definite and fundamental, and it was on these that our work was based; but pH values are complicated and rather unprepossessing, conveying little to those unfamiliar with them. We propose, therefore, in this summary, to avoid reference to pH values as far as possible, and to use instead the descriptions given above, with the warning that they are not to be read too literally; readers familiar with the pH notation can easily translate our results by reference to the table.

In the course of the work in parish D, the first to be surveyed, it was soon observed that the fields under crop were more acid than the fields in grass; it is, therefore, deemed advisable to treat separately of the pastures and of the fields under crop. Land known to have been limed within the previous four years is also dealt with separately, while the moorland, under the heading "unenclosed land," forms yet another class. "Enclosed land," in our tables, implies practically all that is not open moorland, and includes both limed and unlimed fields.

PARISH C.

Parish C, in Dumfriesshire, is inland, and includes various characteristic types of mixed farming. Practically all the farms have both sheep and arable land, while nearly half have dairy cows. The samples examined represent, in all, 10,742 acres, made up as follows :—

Pasture (unlimed)	3,735	acres, or 35 per cent.
Fields under crop (unlimed)	2,008	acres, or 19 ,,
Recently limed fields ...	1,559	acres, or 14 ,,
Unenclosed land	3,440	acres, or 32 ,,
Total	10,742	acres.

There is also a considerable amount of woodland.

Topography.—The parish contains three valleys, with arable land at an elevation of 200 to 600 feet, and rolling moorland between, rising to 800 feet; there is also a considerable flat stretch of deep, river alluvium. The annual rainfall is about 40 inches.

Geology.—Apart from the alluvium, the soil is composed of glacial drift, lying on silurian rocks: greywacke, argillaceous shale, flagstone and shale.

Soils.—More variety of soil is found here than in parish D, but, on the whole, the cultivated land consists of medium to heavy loams, stony, and of a red-brown to dark-brown colour; the moorland soils are more clayey. The alluvial land by the river appears to be more fertile, but is not discussed separately in this account since its acidity does not differ appreciably from that of the boulder clay soils.

Enclosed Land.—It will be seen from Table 1 that 66·4 per cent. of all the enclosed land in the parish is (at least) "strongly acid," and only 9 per cent. can be described as "fairly acid," "slightly acid" or "alkaline." It was not possible to trace the history of every field, and the conclusion seems warranted that this 9 per cent. includes only those fields which have been limed or slagged within recent years. Acid-tolerating plants like sheep sorrel (*rumex acetosella*) are common.

Pastures (unlimed for four years).—79·6 per cent. of the acreage under grass is "strongly acid" or worse; yet most of the pastures here are, to all appearances, of quite good quality, and few show signs of essential poverty, although, where lime has been applied to one part of a field, an improvement in the herbage is visible. Many apparently very good pastures were found on land that is "strongly acid" (down to pH 5·1 and less). There is no evidence that acidity, on the whole, is the limiting factor, and the relative values of the pastures, even those managed by the same farmer, cannot be correlated with the wide differences that were often found in the acidity. One must, of course, bear in mind that no information is available as to the true nutritive value of the pastures, which may not be the same as their apparent goodness; this point is discussed at the end of this paper.

Land under Crops (unlimed for four years).—In this parish the land under crop (including hay) showed less variation in acidity than did the grassland, and was less acid; this is in direct contradiction to the results obtained in parish D, described later. The figures are given in Table 3.

Unenclosed Land.—The moorland, used for sheep runs, is less peaty than that in parish D, and there is less heather. Probably on account of its lower humus content, its acidity is also less. See Table 5.

Subsoil.—Samples of the subsoil, taken from about every fourth field, showed great variation in acidity, but no neutral or alkaline samples were found, even at depths of 30 inches. The

following table, applicable to subsoils at 9 to 16 inches from the surface, summarises the results :—

	Per cent. of Samples.	
	Enclosed Land.	Unenclosed Land.
Subsoil less acid than soil	67	85
Subsoil more acid than soil	33	15
Subsoil "slightly acid" or "fairly acid" ...	10	23
Subsoil "acid"	40	0
Subsoil "strongly acid"	42	54
Subsoil "very strongly acid" or "abnormally acid"	8	23

PARISH D.

Parish D is in Wigtownshire and represents a large area of the dairying and cheesemaking districts in the South-West. All the holdings are mainly arable. Some early potato land is included. The soils examined represent :—

Pastures (unlimed for 4 years)	6,335 acres, or 52	per cent.
Fields under crop (unlimed for 4 years)	3,313 acres, or 27	,,
Recently limed fields	1,130 acres, or 9	,,
Unenclosed land	1,461 acres, or 12	,,
Total	12,239 acres.	

Topography.—The parish lies near the coast and has an annual rainfall of about 35 inches. The land slopes gently from near sea level to a height of 500 feet, the cultivated land extending to the highest parts.

Geology.—As in parish C, most of the land lies on the silurian formation that is so extensive in the South of Scotland. The rocks are greywacke (varying from fine-grained mudstone to coarse sandstone), interbedded with partings and beds of shale, usually hard and splintery. The covering of boulder clay, averaging 6 to 8 feet deep, is apparently derived almost wholly from the rocks of the district. It is obvious, then, that, on the whole, the soils of the two parishes have had a very similar origin, and that whatever broad differences are found in them may be attributed to differences in their history, such as climate, for instance, and cultivation.

There is a boss of granite, consisting of orthoclase, quartz and black mica, with sometimes the addition of hornblende in considerable quantity; raised beach deposits are also present.

Soils.—The soils on the greywacke and granite are very uniform in nature, being, typically, light to medium loams of a red or red-brown colour, and containing a great quantity of stones, varying from small fragments up to pieces a foot in diameter.

The raised beach soils vary from sand to medium loam, and they also are often very stony. As in parish C, the different

kinds of soil are not characterised by any difference in acidity, and so are not here discussed separately.

Enclosed Land.—In acidity, as in soil texture, the enclosed land in parish D exhibits more uniformity than that in parish C. The predominant group falls near the border-line between "acid" and "strongly acid" (28·6 per cent. of the acreage has a pH value between 5·4 and 5·7). Only 651 acres (6 per cent. of the enclosed land) falls within the first four groups (down to and including "fairly acid"), and of these almost half are known to have been limed within the last four years; it is considered probable that only land that has been treated with lime or slag comparatively recently is included in these groups. 61·2 per cent. of the land is "strongly acid" or worse. Acid-tolerating weeds are very common.

Pastures (unlimed for four years).—Detailed results which it is not possible to reproduce here, show that the pastures of parish D vary very little in acidity, especially when allowance is made for peaty patches in the permanent pastures, in hollows and near the edges of the moorland areas. The grass land in parish D is definitely less acid than that in parish C; in this connection it is probably not without significance that the parish D farmers are more dependent on good grazing from their system of farming. Here, as in the other parish, the appearance of the grass indicates acidity, but not such widespread and pronounced sourness as the figures might lead one to expect; the pastures, on the whole, looked quite good, and were heavily stocked with dairy cattle, yet, with 57·8 per cent. in the last four acidity-groups, they cannot be otherwise described than as very acid. This point is further discussed below.

Land under Crop (unlimed for four years).—In this area, in contrast to parish C, the land under crop showed much more irregularity in its acidity than did the pasture, and was generally more acid than the grass land. This may possibly be connected with the fact that parish D was sampled earlier in the year—in late spring and early summer, when biological and chemical changes (e.g. the formation and absorption of nitrates) would be taking place at the maximum rate; of this aspect of the problem of soil acidity, however, very little is known, or can be known until a great deal more work has been done.

About 80 per cent. of the land under crop (including hay) in parish D was "strongly acid."

Unenclosed Land.—The unenclosed land has already been compared with that in parish C. It may be noted that, in both parishes, the virgin moorland shows great variations in acidity, samples taken quite close together, on apparently uniform land, giving very different values. Here, too, an inch or two of difference in depth, at any given spot, gives quite a large difference in the acidity, especially in the upper layers of soil.

Subsoil.—Owing to the extreme stoniness of the ground, which prevented any use of the auger, comparatively few subsoil samples were obtained. The results indicate, however, that

the lower layers (below 9 inches) are uniformly less acid than the upper and commonly reach somewhere near neutrality at depths of 20 to 30 inches.

Sourness Tests.—*The "Soiltex" Test.*—The "Soiltex" outfit is a cheap and convenient pocket apparatus (a proprietary article of American origin) designed for the rapid testing of soils. A pinch of soil, on a piece of waxed paper, is treated with a few drops of a greenish liquid; the latter alters its colour, and in this way indicates to what acidity-group the soil belongs. Since this test, the first of its kind to come into common use, has been widely employed in Scotland, a comparison of the results obtained by means of it in the field with those established for the same soils in the laboratory is considered to be of some practical importance. As the acidity groups into which the soils are classified by the makers of the Soiltex outfit differ somewhat from those (Dr. Ogg's) employed in this paper, we are forced to the use of pH values in order to avoid confusion. By referring to the table given near the beginning of this account, it is hoped that the non-technical reader who is interested in this matter will be able to get the gist of the results of the test.

It was found that the pH value indicated by the Soiltex, if over 5·6, was nearly always accurate; below this figure, however, very little reliance could be placed on the test. The colour representing the range pH 5·0—5·6 was given quite regularly by soils having true pH values of from 4·8 to 6·2, while the most acid Soiltex indication (pH under 4·9) was given by hundreds of samples, the real pH of which was found to be anything up to 5·5. These results, it may be added, are in accordance with previous experience in the West of Scotland; but they may not hold with soils in other parts of the country.

(2) *The B.D.H. Soil Testing Outfit.*—This is a British outfit similar to the Soiltex, but a different liquid is employed. Many tests were made with it; but, during the present survey, it was deemed advisable to make an exhaustive study of the reliability of one method, the Soiltex. It may be said briefly that the results obtained by means of the B.D.H. outfit were good, except near the neutral point. The fact that its range does not extend far enough on the acid side militates against its usefulness in surveying soils like those found in the two parishes under consideration.

(3) *The Potassium Salicylate Test.*—In the laboratory some hundreds of samples were submitted to the potassium salicylate test of Comber: i.e. an ounce or so of soil was shaken up in a glass tube with a solution of potassium salicylate in water.

Practically all of them gave the red colour, indicating acidity; but no correlation could be traced between intensity of colour and degree of acidity, even amongst soils of the same type, texture and humus content. This, also, agrees with our experience of other West of Scotland soils.

(4) *Weeds as Indicators of Acidity.*—It has long been known

that certain weeds serve as rough indicators of the need for lime, since they can flourish in very acid soils. Copious notes were made on the weed flora in each plot, particularly in the pastures, in these two parishes. The results of our observations were, briefly, that some or many of such weeds (e.g. sour dock, sheep's sorrel, bracken, ling, foxglove, spurrey) were found in almost every plot, including those that were only slightly acid, and that the relative prevalence of these weeds formed no guide to the comparative acidities of different areas. In the most acid fields, however, the leaves of these weeds were frequently red. In some places there is remarkable growth of bird's foot trefoil, and this also was investigated, but seems to be quite unconnected with soil acidity. The common red clovers were found to be the most reliable of the plant indicators; comparatively few were found in these parishes, and practically none on the more acid land.

Discussion of Results.—The figures here presented show that the soils in both parishes are extremely acid; indeed, it may be doubted whether two parishes, on good agricultural land, chosen at random in any other part of the country, would show so much acidity. To what extent they are typical of their own area (the West of Scotland) it is at present not possible to say; but we have no reason to suppose them to be exceptional.

Diagram 1 shows how parishes C and D compare with the two East of Scotland parishes, A and B, reported on by Ogg and Dow (*Scottish Journal of Agriculture*, July 1928, vol. xi, page 280). The contrast is indeed striking; and we have studied only one factor, soil acidity. Where differences such as these, fundamental and perhaps unsuspected, may exist, on what basis can one compare farming methods in different localities, or how shall one apply to one district inferences drawn from the results of agricultural experiments in another? Considering the figures as they stand, and in the light of existing knowledge as to the requirements of different plants, one may say with a reasonable amount of confidence that certain crops (sugar beet, for instance) are very unlikely to succeed in parishes C and D; and, in practice, these crops are not grown there. But we feel that a good deal of emphasis must be laid on the fact that soils such as these can give rise to pastures of very fair quality and of high stock-carrying capacity. Here, however, we touch on a question which, vital though it is to West of Scotland farmers, cannot profitably be discussed until much more information has been patiently collected, for it is now being realised that grass that looks good and healthy may be deficient in various constituents that are essential to the well-being of the animals that live on it. The question suggests itself, for instance, whether soils such as these can produce pasture having a sufficient mineral content. In the agricultural survey referred to at the beginning of this paper it was found that in the dairying parish, D, there is a considerable loss from disease among cattle (tuberculosis, hoose, scour, abortion), while milk yields leave ample

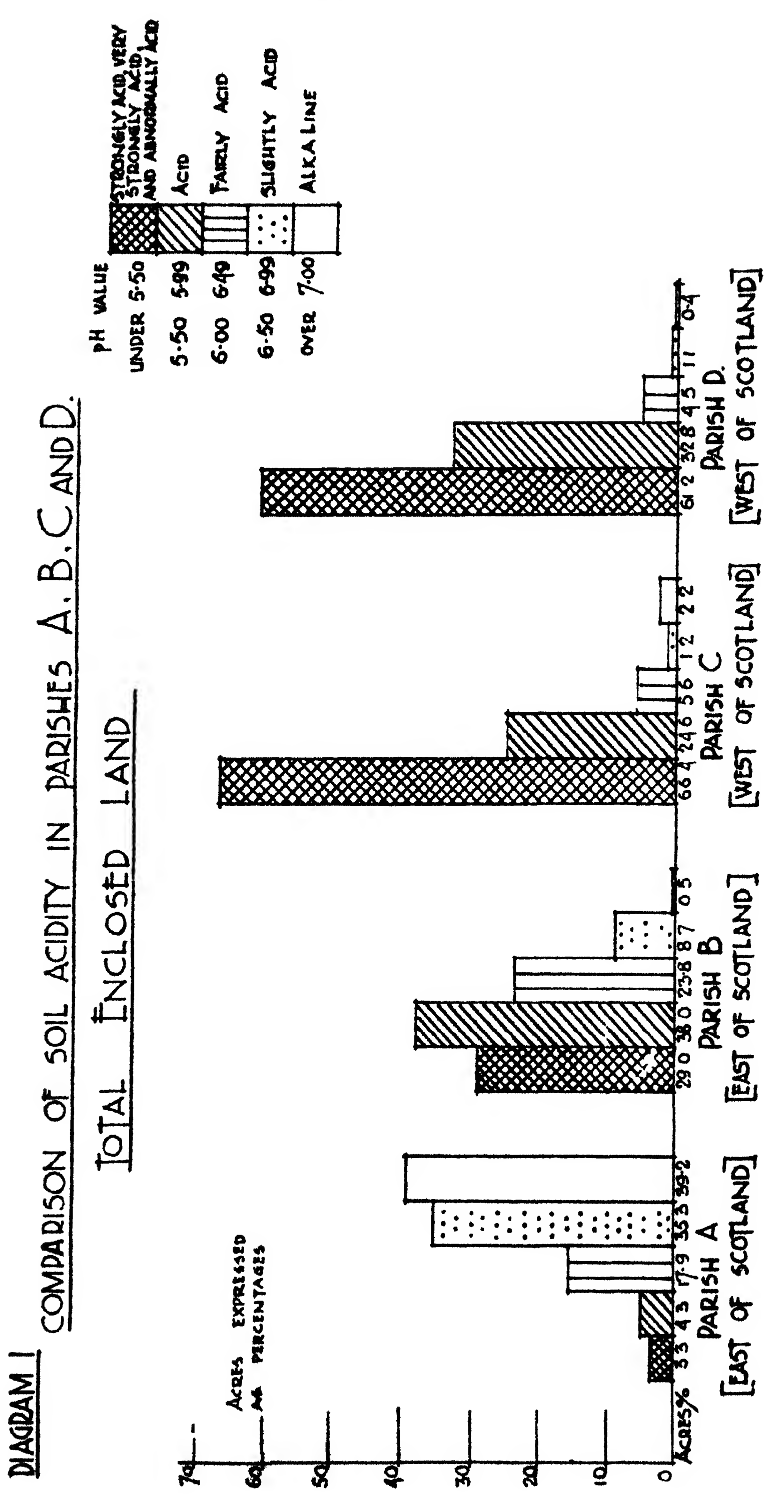


DIAGRAM I
COMPARISON OF SOIL ACIDITY IN PARISHES A. B. C AND D.
TOTAL ENCLOSED LAND
ACRES EXPRESSED AS PERCENTAGES
pH VALUE
UNDER 5·50 STRONGLY ACID, VERY STRONGLY ACID, AND ABNORMALLY ACID
5·50 5·99 ACID
6·00 6·49 FAIRLY ACID
6·50 6·99 SLIGHTLY ACID
OVER 7·00 ALKALINE
ACRES%
0
10
20
30
40
50
60
70
3·3 4·3 17·9 35·3 39·2
PARISH A
[EAST OF SCOTLAND]
29·0 38·0 23·8 8·7 0·5
PARISH B
[EAST OF SCOTLAND]
66·4 24·6 5·6 1·2 2·2
PARISH C
[WEST OF SCOTLAND]
61·2 32·8 4·5 1·1 0·4
PARISH D.
[WEST OF SCOTLAND]

room for improvement. This state of affairs is not found in parish C; but, there, the farming is of a more mixed type, and the cattle are not usually kept so long. On the other hand, we have, of course, no reliable evidence that the pasture is not really as good as it looks, and in this connection the relative maturity or immaturity of the soils might also repay investigation by helping to answer the question whether, although the supply of readily available bases (calcium, for instance) is small at any given time, and barely sufficient for plant needs, it may be in process of comparatively rapid renewal by the continued decomposition of complex soil minerals, thus avoiding any actual deficiency.

It is not proposed to discuss here the lime requirements of these soils, although this acidity survey should eventually afford valuable help in that matter. In order that the results of this investigation may be turned to practical account and the best returns obtained from applications of lime to the land in these two parishes, *ad hoc* field trials, carefully planned, would have to be carried out. As would be expected, lime has given good results where it has been applied, and the difference in the vegetation is usually visible.

TABLE 1.

Enclosed Land.

pH Value.	Description of Reaction.	Parish C.		Parish D.	
		Acres	Acres per cent.	Acres.	Acres per cent.
7 50 and over	Alkaline.	...	...	47	0·4
7 00–7 49	Do.	159	2·2	.	...
6 50–6 99	Slightly acid.	84	1·2	131	1·1
6·00 6·49	Fairly acid.	412	5·6	473	4·5
5·50–5·99	Acid.	1,794	24·6	3,536	32·8
5·00–5 49	Strongly acid.	3,854	52·8	4,303	47·2
4 50–4 99	Very strongly acid.	932	12·7	2,099	12·2
4 00–4 49	Abnormally acid.	67	0 9	189	1·8
3 50–3·99	Do.	...	...	...	...
Under 3 50	Do.	...	...	...	..

TABLE 2.

Pasture (unlimed for four years).

pH Value.	Description of Reaction.	Parish C.		Parish D.	
		Acres.	Acres per cent.	Acres	Acres per cent.
7·50 and over	Alkaline.	...	...	...	..
7·00–7·49	Do.	...	...	...	...
6 50–6·99	Slightly acid.	11	0·3	...	...
6·00–6·49	Fairly acid.	59	1·6	270	4·2
5·50–5·99	Acid.	691	18·5	2,406	38·0
5·00–5·49	Strongly acid.	2,305	61·7	3,056	48·3
4·50–4·99	Very strongly acid.	611	16·3	535	8·4
4·00–4·49	Abnormally acid.	58	1·6	68	1·1
3·50–3·99	Do.	...	...	...	...
Under 3·50	Do.	...	...	...	...

TABLE 3.

Fields under Crop (unlimed for four years).

pH Value.	Description of Reaction.	Parish C.		Parish D.	
		Acres.	Acres per cent.	Acres.	Acres per cent.
7·50 and over	Alkaline.	...	...	...	...
7·00–7·49	Do.	...	...	...	...
6·50–6·99	Slightly acid.	...	...	9	0·3
6·00–6·49	Fairly acid.	66	3·2	75	2·3
5·50–5·99	Acid.	620	31·0	590	17·8
5·00–5·49	Strongly acid.	1,118	55·7	1,806	54·5
4·50–4·99	Very strongly acid.	195	9·7	712	21·5
4·00–4·49	Abnormally acid.	9	0·4	121	3·6
3·50–3·99	Do.	...	...	...	...
Under 3·50	Do.	...	...	...	...

TABLE 4.

Recently Limed Fields.

pH Value.	Description of Reaction.	Parish C.		Parish D.	
		Acres.	Acres per cent.	Acres.	Acres per cent.
7·50 and over	Alkaline.	...	...	47	4·2
7·00–7·49	Do.	159	10·2	...	.
6·50–6·99	Slightly acid.	73	4·6	122	10·9
6·00–6·49	Fairly Acid.	287	18·4	128	11·3
5·50–5·99	Acid.	483	31·1	540	47·8
5·00–5·49	Strongly acid.	431	27·6	237	20·9
4·50–4 99	Very strongly acid.	126	8·1	56	4·9
4·00–4·49	Abnormally acid.	...	...	...	.
3·50–3·99	Do.	...	...	...	...
Under 3·50	Do.	...	...	...	.

TABLE 5.

Unenclosed Land.

pH Value.	Description of Reaction.	Parish C.		Parish D.	
		Acres.	Acres per cent.	Acres.	Acres per cent.
7·50 and over	Alkaline.	...	...	...	...
7·00–7·49	Do.	...	...	...	...
6·50–6·99	Slightly acid.	...	...	...	...
6·00–6·49	Fairly acid.	50	1·5	...	...
5·50 5·99	Acid.	178	5·2	12	0·8
5·00–5·49	Strongly acid.	506	14·7	340	23 2
4·50–4·99	Very strongly acid.	2,098	60·9	415	28·4
4·00–4·49	Abnormally acid.	285	8·3	243	16·7
3·50–3·99	Do.	323	9·4	445	30·5
Under 3·50	Do.	...	...	6	0·4

THE BIOLOGIST on the FARM.—No. XXXV.

Professor J. ARTHUR THOMSON, M.A., LL.D.,
University of Aberdeen.

Beneficial Insects.—We are perhaps too apt to think of insects with a frown. They are so destructive to crops and stores; they are the vehicles of so many diseases, such as malaria and sleeping sickness; not a few are troublesome parasites, such as warble-flies and bot-flies; and most of them are so prolific that they might soon smother all other living creatures, if they did not turn on one another, and if they were not kept in check by birds and bad weather. Now this frowning at insects is not unreasonable, and the damage they do is a useful warning against thoughtless or short-sighted disturbances of the Balance of Nature. Yet we should at times correct our partial outlook by remembering the sweetness of honey—especially in the honeycomb, and the softness of silk—especially when it comes out of a silkworm. And besides other useful things that insects make, we should remember that the linkage between flowering-plants and their insect-visitors is the most important inter-relation in the world, for it secures in the majority of cases that cross-pollination which increases both the quantity and the quality of the fertile seed. It is hardly magnanimous to dwell on clothes-moths and potato-beetles, and to forget that insects have played a notable part in the evolution of flowers. Nor should we forget that in a deep sense insects are always turning into birds—entering upon another avatar at a higher level. But, coming down to a matter of fact question, let us take a brief survey of the beneficial insects as far as agriculture in the wide sense is concerned. No doubt this has often been done before, but we have short memories. Who are the farmer's insect friends? First, there are the reddish or yellowish Ladybirds, most charming of little beetles, which do no end of good by devouring aphids or Green Flies, which are altogether to the bad. But it is a pity that we have not a more precise acquaintance with the unprepossessing blackish grubs, whose appetite is such that one grub can eat three dozen aphids without stopping. They emerge from eggs which the mother Ladybird lays in small groups on the stem or under the leaves of a plant that is infested with aphids. She may not be intelligent, but she behaves as if she were—with an unconscious prevision difficult to understand.

Second, there are the Ichneumon Flies, in the same order (Hymenoptera) as saw-flies, wasps and bees. They are perhaps our best friends, best in the sense of being most effective in warding off the disaster of over-population among injurious insects. They are active aggressive creatures, of all sizes from that of a capital on this page up to that of a hornet; and their peculiar trick is to lay their eggs in the young stages of other insects. Within these the ichneumon grubs develop and proceed to devour their shelter. No doubt they destroy many useful insects, but against this there has to be weighed the fact that

they attack and destroy most of the many grubs and caterpillars of insects that damage our crops. Not only do the larvæ make sure work of their victims, which they devour from within like internal beasts of prey, but they are themselves in relative safety all the time. As for the adults, they can look after themselves.

Lacewing Flies deserve a prominent place, for they are as useful as they are beautiful. Many are fascinating, with their delicacy of build, their green colour, and their golden eyes. The lace-like wings, which indicate some relationship with Dragon Flies, are longer than the body, and when at rest are carried flat against the sides. The eggs are laid in groups, and each is borne on the end of a long hair-like stalk. From the eggs there emerge dark brown grubs, which often mask themselves with little pieces of lichen or bark or with the empty husks of their victims. They have a great appetite for aphids and Scale insects, and are altogether to the good.

Some of the Hover Flies or Syrphids, which we often see hovering and darting and settling in the garden on a sunny day, deserve honourable mention, for their larvæ devour aphids. The flies are somewhat bee-like or wasp-like, but they are two-winged Diptera; and the dirty-white or greenish larvæ are maggots. Also among the beneficial Diptera are the House-fly-like Tachinids, which lay their eggs on or near caterpillars and grubs. These the maggots eventually devour in Ichneumon fashion. Such are a few of the beneficial insects.

Economic Importance of Bats.—Professor Edward B. Poulton, to whom entomology and biology owe so much, has made a careful study of the booty of insectivorous bats. The Long-eared Bat feeds largely on several kinds of Noctuid moths, which are well concealed during the day. In some cases the moths that are devoured are prejudicial to crops. It is reported by Rollinat and Trouessart that a captive adult Mouse-ear Bat accounted for 1,000 house flies in one night and 1,500 on the following night, 67 and 80 large grasshoppers on two other nights. So there is no doubt as to appetite! Cockroaches formed the usual food supplied to this bat.

Professor Poulton gives some very interesting data for Britain. The Long-eared Bat carries moths, one at a time, to shelters and devours them except the wings; the Greater Horseshoe does the same; other British bats chiefly feed in the course of their flight. If the prey is large or intractable, it is "pouched" or thrust, still held by the jaws, into the inter-femoral membrane, where the grip can be safely adjusted. The Horseshoe Bats do the same by thrusting the head into the interbrachial membrane. The Long-eared Bat captures not only moths (mostly Noctuids), but beetles and Diptera. The Noctule feeds chiefly on large beetles, besides winged ants and Mayflies. Leisler's Bat feeds voraciously on Diptera; the Serotine catches cockchafers; the Greater Horseshoe Bat preys on beetles and moths; the Lesser Horseshoe Bat takes small moths and flies. Of course some of the insects captured are *not* injurious, and some tropical bats

prey upon insectivorous birds. But on the whole it has been proved that British bats are of great economic value to man. "Their attacks upon Lepidoptera and Diptera, carried on during hours when the prey is active or easily disturbed, must produce a considerable effect, especially when their quickly renewed voracity is taken into account."

Fertility of Cocks.—It is common knowledge among poultry breeders that there is often much difference in the fertility of cocks of the same breed under the same environmental conditions. The possible factors that may account for the differences have been experimentally studied by F. B. Hutt in the Animal Breeding Research Department of Edinburgh University. The fertility is not in any way dependent on the size of the testis. The average density of sperm suspension was found to be approximately four million spermatozoa to the cubic millimetre, but variations in the average density from different birds ranged from 825,000 to 7,000,000 sperms per cubic millimetre. But this range of density is not related to fertility, nor to the size of the testes. It was found that if one testis is removed from a chick a week old, there is a compensating growth of the remaining testis, to the extent that it may eventually weigh as much as two normal testes. The negative nature of the results suggests that the fertility of the cock is dependent on the physiological efficiency of the spermatozoa. It is qualitative rather than quantitative.

Mortality among Unhatched Chicks.—A surprisingly large number of chicks fail to hatch. Mr. Hutt writes: "The loss to the poultryman from mortality among embryos during incubation is probably second only to that from disease; and even when conditions of nutrition and incubation are ideal, so far as present knowledge goes, there is still a mortality in the incubator that may range as high as 50 per cent. of the fertile eggs, and is seldom less than 25 per cent." One cause of death is malposition of the embryo. Something goes wrong, and the head is buried between the legs, which definitely prevents hatching. Among 5,000 embryos which died after the eighteenth day, 9·25 per cent. showed this fatal malposition. Three other malpositions are common, and usually have a fatal result by preventing pulmonary respiration in the embryo as well as by mechanical hindrance. Of the embryos over eighteen days, nearly 56 per cent. showed one or other of the four major malpositions. But what causes the malpositions? In some cases at least it seems likely that there is a displacement of the embryonic axis from its normal position at right angles to the long axis of the egg. But the factors causing the displacement remain obscure.

Another cause of mortality in unhatched chicks, studied by Hutt and Greenwood, is the occurrence of "parrot-beak" embryos with very short legs. The abnormality corresponds to "bull-dog" monstrosities in calves and to a peculiar kind of dwarfing in mankind. It is technically called chondrodystrophy, and is not to be confused with leg-weakness or avian rickets, which is due to a lack of vitamin D or of adequate minerals or

both. Evidence is advanced in support of the theory that the abnormality is due to something wrong with the hen's health or constitution, and that the tendency to produce it is inherited. Under the same environmental conditions some hens show the "hereditary physiological abnormality" while others do not. The occurrence of the "parrot-beak" condition in the embryos appears to be independent of the breed of fowl, the sex of the embryo, and the age of the mother; but its incidence seems to be inversely proportional to the amount of sunshine. The suggestion is made that lack of direct sunlight is a factor in inducing the abnormality.

Another study by Hutt and Greenwood concerns "monsters" in chick embryos that failed to hatch. In 11,797 eggs, 433 monstrous specimens were found, such as forms without a roof to the skull, with protruding brain, with one eye or none, without a proper beak, and so forth. Such monsters accounted for at least 3·6 per cent. of the mortality. A very probable cause of the production of monsters in the chick is an arrest of development at a critical stage, and this may be due to an early chilling of the eggs. In connection with monsters it is interesting to notice that under man's ægis many things are possible; for in such breeds as the Polish Crèvecœur and Houdan, a rupture of the forebrain is typical!

The Size of a Gene.—The most important bodies in the invisible vital world are the "genes." And what are they? A "gene" is the smallest separable particle of living matter that contains the initiative of a single Mendelian difference. If two pea-seeds, that often look so much alike, happen to be really similar except that one will grow up into a tall pea, and the other into a short pea, the statures are Mendelian differences, behaving in a well-known way in inheritance. And the initiative for the stature-difference lies in a gene, carried along with hundreds of others in a nuclear rodlet or chromosome.

If two eggs of a hen that look identical when we hold them in our hand happen to be really similar except that one will develop into a fowl with feathered shanks and the other into a fowl with bare shanks, then the initiative for the state of the shanks lies in a gene, carried with hundreds of others in one of the nuclear chromosomes. Now when the biologist comes to know a living creature very intimately, as in the case of the Fruit-fly Drosophila, he can in more than one way make an approximate estimate of the number of these Mendelian differences, and thus get at the number of genes. In the case of the Fruit-fly the minimal number must be between 1,400 and 1,800. But the genes or hereditary initiatives lie in linear order in the chromosomes, which are visible and measurable. Now, as H. J. Muller has been doing, it is readily possible to divide the minimal number of genes into the bulk of the chromatin that contains them; and this gives the maximal diameter possible for an average gene at about a twentieth of a micron, just within the range of size of ultra-microscopic, colloidal bodies. A micron is

one millionth of a metre, and an average gene cannot be more than a twentieth of that. But just as an average atom is a microcosm, so the gene has its parts; for though it is peculiarly stable it permits mutations. Into the structure of the gene it will be necessary for the biologist to penetrate. Muller has a rather fine sentence: "We cannot leave forever inviolate in their recondite recesses those invisibly small yet fundamental particles, the genes, for from these genes, strung as they are in myriad succession upon their tiny chains, there radiate continually those forces, far-reaching, orderly, but elusive, that make and animate our living worlds."

Proving Blood Relationship.—When animals are in the strictest sense related to one another, we call them "blood-relations," and there is the same idea in the word consanguineous or cousin. The blood affords a sort of biochemical summary of the animal's constitution, and it can be used as a test of real relationship. It is well known that the blood-serum of a rabbit which has previously had human blood injected into it, forms a precipitate when added to human blood, and gives almost as marked a precipitate in the blood of an anthropoid ape, but less in an Old World monkey, almost none in a New World monkey, and none at all in a mammal of some different order altogether. So that the serum injection may be used not only as a test of blood-relationship, but as an index of its closeness. The original method has been considerably improved, and Sasaki has recently used it in a new field, to test the relationship between domesticated birds and their wild ancestors, ducks in particular. He finds that the Japanese duck is distinguishable by the ordinary precipitation method from the Chinese goose, but not from many kinds of wild duck. This shows that the Japanese duck is more closely related to the wild duck than it is to Chinese geese. And yet by a refinement of the method it is possible to distinguish the domesticated Japanese duck from various kinds of wild duck, including its own wild form, *Anas boschas!*

Sensitiveness to Parasitic Worms.—Infection with parasitic worms may have various evil consequences. Some tapeworms, present in large numbers, absorb a considerable quantity of digested food; some threadworms may perforate the wall of the food-canal and bring on peritonitis; the hookworms cause anæmia by sucking blood from the intestinal wall; the gapes worms may choke the chicken's windpipe; and so forth. But it has often seemed as if, in addition to all the familiar damage, the exudations of certain parasitic worms had a poisoning or toxic effect on the host. One reason for this suggestion is the undoubted sensitiveness that some people show to cutaneous contact with certain helminths, such as the Ascaris threadworms of horse and of man. Often there is a hypersensitiveness comparable to that which some people show to the pollen that causes hay-fever, or to even small quantities of particular foods, such as egg. Some interesting experiments have been recently made by F. A. Coventry and W. A. Taliaferro. Protein extracts of Ascaris were made

and introduced by scratches into the skin of 130 Honduras patients, with the result that 80 per cent. of them showed wheal formation and erythema within twenty minutes. Similarly with 80 per cent. of 84 patients tested by the scratch method with hookworm protein extract. So again with 25 per cent. of 64 patients tested with Trichuris extract. In none of the three sets of experiments was there any correlation between the hypersensitivity and the presence of the relevant parasites within the patients. So the tests have no diagnostic significance. Yet practically all the natives studied were probably infected with Ascaris at some time in their lives, and it is suggested that the hypersensitiveness is correlated with previous infection with the parasites in question. This view is confirmed by the results of precipitin experiments.

Behaviour of Buntings.—Some years ago Mr. H. Elliot Howard pointed out that the males of some of our common birds, such as the warblers, select a "territory" which comes to be the centre of their summer life. It may be a tree or a bush or a corner; it is a preserve for courting and nesting; and by and by the female bird will abet the male in fighting for its sanctity against intruders.

Mr. Howard, who is one of the best observers in Britain, has just published a big book on "Bird Behaviour," in which he shows very convincingly that "territory" means much to many birds. It is to the bird what "home" is to us. Two birds are studied in special detail, the Reed Bunting and the Yellow Bunting or Yellow Hammer. Let us keep to the latter, a universal favourite and one of our handsomest birds. It is a resident in Britain, common on hedgerows and in waste places. In summer the Yellow Hammers catch many insects; in winter they are more markedly vegetarian, and may be seen searching in the fields and hedges for seeds and small fruits. Often they go about together in lively little flocks.

Early in spring the full-grown males segregate themselves, and each sits alone in a chosen prominent place. One chooses an oak-tree, another a whin bush, a third a conspicuous mound. This is for each his territory, where he sits and begins to sing. By and by he drives off any other male who comes near. About the end of February the second chapter begins, connected partly with the weather without, and partly with the hormones within. A female appears on the territory, and the male is interested. He poses and postures, shows himself off, chases her about, and, strangely enough, becomes as silent as he was previously vociferous. But there will not be any pairing for a month or two yet! The third chapter is marked by a change in the female. She becomes interested in the home and in its master, with whom she now keeps company, ceasing to gad about. She begins to drive off intruding females from the territory. At the end of two months, or it may be a month, a new note is struck. The female picks up a piece of dried grass, and lets it fall again. But this is often repeated, and it is a hint of nesting. At this time

there is actual pairing, and in a week or so a nest is built, and the first egg is laid. The fourth chapter is brooding, and the two parents are companions. The male sings again and fights. But when the young are hatched he soon begins to imitate his mate in collecting insects, feeding the young, and keeping the nest clean. He is thoroughly domesticated.

This is but an outline of a long story, disclosing an unsuspected intricacy in the behaviour of one of our commonest birds. And what is most interesting, perhaps, is that we cannot make sense of it unless we add to the physiological story of summer weather and hormones and the like, a psychological story or aspect of the story, in which a mental picture of the home counts for much.

Roadways and Bird Life.—It is a safe proposition that any change that is prejudicial to insectivorous birds is against successful agriculture, and this lends interest to a study by Miss Jean M. Linsdale on the influence of roads on bird life. The paper refers especially to North America, but its relevance to Britain is plain. We select a few points. Roadside tangles afford much food and shelter; roadside ditches supply meat and drink; hedges and banks are useful for shelter and cover; many birds are attracted to roads where there are pools in which they can bathe; others find food in the horse droppings; hedges, wild strips, and banks are common nesting places. "The set of conditions which go along with roads is such that a large bird population can live there." The general moral is that extreme tidiness may defeat itself by lessening the shelter for economically useful birds.

On the other side of the account it may be noted that many birds are run over, and that many are killed by knocking against wires; but neither of these minus factors is very serious. On the whole, according to Miss Linsdale, the beneficial influences of roads more than offset the harmful influences as far as bird-life is concerned.

RECENT RESEARCH ON THE DOSAGE OF SHEEP INFESTED WITH LIVER FLUKES.

R. F. Montgomerie, B.Sc., Ph.D., F.R.C.V.S.,

Veterinary Adviser, Department of Agriculture, University College of North Wales, Bangor

An investigation into the value of certain drugs in the destruction of liver flukes infesting sheep has been in progress at the Department of Agriculture of the University College of North Wales, Bangor, since 1924. Of the drugs so far tested pure carbon tetrachloride appears most satisfactory. Dosage with

that drug has been recommended for the treatment and control of liver rot (fluke disease) of sheep since 1926. In many parts of the Empire where this disease is important it has been adopted and millions of sheep have been successfully treated during each of the past two seasons. It was, however, early recognised that this mode of treatment, a single dosage with 1 c.c. of pure carbon tetrachloride in soft gelatine capsule, killed only those flukes which were mature and those approaching maturity. Further research, designed to determine more accurately the efficiency of this drug, has been conducted.

Artificial Infestation of Sheep with the Common Liver Fluke.—For the type of investigation necessary it was essential to have the experimental sheep infested to a known degree at a particular time. The degree and type of infestation among sheep of a naturally infested flock vary greatly. A technique of artificial infestation had to be evolved in the first place.

Suitable means of collecting the encysted cercarial stage of the fluke were found. The cercarial stage is that which leaves the intermediate host snail, *Limnæa truncatula*, and settles on a blade of grass, there to form an adherent cyst. When grass so contaminated is eaten by a sheep (or other suitable host) the tiny larval fluke is liberated in the intestine whence it makes its way to the liver to mature in the bile ducts and becomes the fluke parasite so well known to most sheep farmers. By administering these cysts to sheep it was found easily practicable to produce infestation artificially and to obtain subjects suitable for experimental purposes.

A series of experiments brought to light several interesting points concerning fluke infestation. Only a proportion of the tiny flukes in these cysts develop and reach the liver. Some either fail to pierce the intestine or become lost, within the abdominal cavity, wandering in search of the liver. Thus, of 2,550 cysts administered to thirty-two sheep only 954 were recovered as liver flukes when the sheep were killed after the lapse of fourteen weeks; i.e., only 37·4 per cent. of the cysts developed. This percentage varied within quite wide limits in individual sheep. In one instance as many as 52 per cent. of the cysts developed, while in another only 8 per cent. of the same batch were recovered as flukes. While it is interesting to speculate as to the reasons for such wide differences, little evidence can be produced to support any theory. The matter merits very careful study. It is possible that some influence which could be applied to limit infestation in the field would be brought to light.

It was found that individual flukes developing from the ingestion of a single batch of cysts grow at different rates and take a varying time to reach maturity. Thus some of the flukes recovered from the liver of a sheep killed twelve weeks after infestation may be one and a quarter inches long and mature to the egg-laying stage, while others are but half an inch in length and far from maturity. These variations may easily be

the result of individuals taking a longer time to journey from the intestine to the liver.

The infestation experiments have also afforded answers to questions relating to the rate of growth of the fluke. They have defined the period which elapses between the ingestion of the cyst and the appearance of fluke eggs in the droppings of the sheep. It would seem that the tiny fluke may spend anything from four to fourteen days, after liberation from the cyst in the intestine, in its wanderings in search of the liver. Within the liver the flukes grow quite rapidly, but even one month after infestation they are still too small to be recognised by other than the skilled eye—being but ¼ of an inch in length. Flukes which have been within the sheep for six weeks or longer should be easily picked out by any careful observer, but it must be borne in mind that individuals of that " age " vary greatly in their size. It has been demonstrated that sheep may commence to pass eggs as early as ten weeks after the ingestion of the encysted stage of the parasite. It is more common for eleven weeks to have elapsed before eggs are found in the droppings, and occasionally sheep may not have commenced to pass eggs even fourteen weeks after infestation. For practical purposes it may be assumed that very few eggs are passed until three months have elapsed since the sheep commenced to graze infective pastures.

The Efficiency of Carbon Tetrachloride Dosage.—Preliminary experiments had indicated that the flukes had to reach some particular stage in development before they could be killed by the dose of carbon tetrachloride ordinarily recommended and used. In proceeding to determine the " age " at which the fluke becomes assailable by dosage the marked variations in the rate of development of individuals following even artificial infestation had to be kept in mind.

The following routine was adopted. The majority of a number of mountain wether lambs—sheep known to be very free from natural infestation—were infested artificially on a particular day, some being held as non-infested controls. These infested sheep were marked to form distinct groups, one of which was left undosed to determine the extent of infestation which had followed the administration of the known number of cysts. The sheep of the remaining groups were given the test dose of carbon tetrachloride but the interval between infestation and dosage was varied for each group. After the lapse of about fourteen weeks from the commencement of the experiment the whole of the sheep were slaughtered. The liver of each sheep was very carefully examined and the flukes recovered were collected, examined and counted. In this manner accurate data regarding the efficiency of the particular dose, administered at known intervals after infestation, was determined.

[TABLE No.

TABLE No. 1.

Dosage with 1 c.c. of Carbon Tetrachloride.

No. of sheep in each group.	Average No. of cysts fed per head.	Dosed. (Period after infestation.)	Number of flukes recovered.	
			Average per head.	Per 100 cysts fed.
		weeks.		
3	42	4	14	33·6
3	42	5	13	31·2
3	42	6	13	31·2
3	42	7	15	36
10	56	8	18·7	33 1
7	70	9	13·9	19·8
7	70	10	2·9	4·1
7	70	11	2 3	3 3
15	57	Infested controls.	24·4	42 8
34	Non-infested controls.		·3	—

Dosage with 1 c.c. of Carbon Tetrachloride.—Table No. 1 details the results obtained in testing the efficiency of dosage with 1 c.c. of the drug. It will be seen that when this dose was given at weekly intervals between the fourth and eighth week after infestation it destroyed very few, if any, of the flukes. Given at nine weeks 44 per cent. of the flukes were killed, at ten 91 per cent., and at eleven 92 per cent.[1] It may therefore be said that dosage with 1 c.c. of carbon tetrachloride will destroy practically all the flukes which have been within the sheep for ten or more weeks.

It was also observed that the flukes which escaped might cause the appearance of eggs in the droppings, in small numbers, as soon as two weeks after dosage.

TABLE No. 2

Dosage with 10 c.c. of Carbon Tetrachloride.

No. of sheep in each group.	Average No. of cysts fed per head.	Dosed (Period after infestation.)	Number of flukes recovered.	
			Average per head.	Per 100 cysts fed
		weeks		
9	100	4	15	15
9	100	5	8 8	8 8
10	100	6	8·2	8·2
10	130	7	1·3	1
10	120	8	1	8
17	100	Infested controls.	34 6	34 6
34	Non infested controls.		·2	—

[1] It will be noticed by those who may happen to check these figures from the table that due allowance has been made for the fact that even in the undosed sheep less than half of the cysts given were recovered as flukes at the end of the experiment.

Dosage with 10 c.c. of Carbon Tetrachloride.—Table No. 2 gives the results of the experiment in which the test dose was 10 c.c. It was found that dosage even four weeks after infestation cleared approximately 50 per cent. of the flukes. 74 per cent. were killed when the dose was given at five weeks, 91 per cent. at six weeks, 97 per cent. at seven weeks and 98 per cent. at eight weeks. It would therefore appear that dosage with 10 c.c. of carbon tetrachloride will destroy practically all flukes which have infested sheep for five or more weeks.

It was found that flukes which escaped when 10 c.c. was given very rarely caused the appearance of fluke eggs in the fæces of the sheep even four weeks after dosage.

Dosage with other Amounts of Carbon Tetrachloride.—The efficiency of dosage with 3 c.c. and with 5 c.c. has also been investigated. It appeared that the administration of 3 c.c. killed flukes only one week less mature than those killed by the administration of 1 c.c. of the drug. Dosage with 5 c.c. cleared all the flukes which had infested the sheep for eight weeks or longer.

The Toxicity of Carbon Tetrachloride.—Since the discovery of the efficiency of carbon tetrachloride in 1925 many thousands of flocks have been dosed in this country, in certain of our Colonies and in some foreign countries. Very generally the results which have followed systematic dosing have been excellent. Reports claim not only a very great reduction in the rate of mortality in the flocks, but also marked improvement in the wool-crop, lamb-crop and the amount of mutton produced. In a few flocks dosage has been followed by the death of a serious proportion of the sheep. While these losses from poisoning are but an infinitesimal percentage of the number dosed, since they have all occurred in a few flocks, certain owners have suffered seriously. Very regularly these losses have been met in flocks which are being hand fed or folded on special crops, but it would appear that sheep in general have a somewhat lower tolerance to the drug during the months from January to April. This very curious state of affairs is at present receiving attention, but the work has not advanced sufficiently far to permit of any pronouncement being made as to means by which these very unfortunate losses can be quite definitely avoided. It is a good practice to dose only a few representative members of the flock in the first place, particularly if the sheep are not on free range or if they are being dosed during the months mentioned above.

Recommendations.—Since 1925, the use of a single administration of 1 c.c. of *pure* carbon tetrachloride in gelatine capsules has been recommended for the treatment and control of liver rot of sheep. The recent work suggests that even greater benefits would follow the employment of a larger dose, and it is believed that dosage with 5 c.c. of the drug would be a sound recommendation. This dose would clear a considerable proportion of the immature flukes and would also kill very many of the stomach and intestinal worms so commonly found concurrently

infesting sheep. Until the toxicity of the drug is better understood, however, it would appear unwise to make such a recommendation. The original advice therefore stands.

It should be emphasised that greatest benefit has followed dosage where the principle that the drug be used more as a means of control than of treatment has been adopted. Farmers whose flocks regularly suffer some loss from fluke infestation should not await the appearance of actual clinical symptoms before dosage is undertaken. By the time a few sheep have shown such signs the majority of the flock have commenced to lose condition—condition which, in the winter season, it is most difficult for them to regain. This consideration makes it obvious that the treatment of affected individuals is uneconomical and that mass dosage, the treatment of whole flocks, should be practised. It also should determine the farmer to dose early in the season. Since the dose recommended destroys only the more mature parasites, a single general administration cannot be expected to protect the flock, at least in the average season. Following wet seasons the farmer whose land is known to be "fluky" is advised to dose his flock at monthly intervals between early October and early April. There may be seriously menaced farms on which such a system is not practicable, but the nearer that "ideal" system of dosage is approached the greater will be the protection afforded The actual system adopted must depend upon several conditions relating to the incidence of the disease, the nature of the season and the opportunities for the collection of the sheep. It must therefore vary from farm to farm, but should always be on the principle of flock treatment In many cases dosage on two occasions, say in October and again in December or January, effects an admirable degree of control.

It must further be emphasised that systematic dosage greatly reduces the possibilities of future infestation By clearing out the mature and maturing flukes, it reduces the distribution of eggs, reduces the opportunity for the propagation of the fluke and so protects against infestation in the year to come

There are special circumstances in which a variation of the generally recommended dose would be attended with advantage. Where the opportunities for the collection of the sheep are limited and it is known that the flock has a high degree of tolerance, 5 c.c. of the drug might well be employed, especially if the sheep are being dosed during the October-December period. It would clear a greater number of the immature flukes. In epidemic seasons it is not uncommon to find sheep die of liver rot relatively soon after they have picked up an immense number of the cysts. Such sheep do not show the usual symptoms but die even after showing only some dullness for a day or two The flukes are too immature to be killed by the administration of 1 c.c. of carbon tetrachloride. In such "acute" outbreaks 10 c.c. of the drug should be used. It has given most beneficial results in one very acute outbreak.

Acknowledgment.—The investigations relating to liver rot of sheep which have been conducted at Bangor during each winter since 1926 were made possible by the receipt of a Special Research Grant from the Ministry of Agriculture.

THE SALE OF MILK.

SUGGESTED AMENDMENTS OF THE LAW.

J. F. Tocher, D.Sc., F.I.C., Aberdeen.

Milk as an article of food comes within the scope of the Food and Drugs Act and the Regulations made by the Central Authority under that Act. Provision is made in the Regulations for legal action in a form compelling the seller to rebut the presumption of adulteration, if he can, in cases where abstraction of butter fat or the addition of water is suspected. Curiously enough in 1901 the fact was overlooked that genuine milk can be rendered non-genuine by the addition of skimmed or separated milk and other fluids as well as by the addition of water.

In former articles to this Journal I have shown the difficulties surrounding the determination of the presence of water in milk.[1] Gross watering can, of course, be detected, but the presence of proportions like 5 or 10 per cent. cannot at present be detected owing to the variations in the proportions of total solids even in bulked samples. I have been at some pains to show the difficulty of determining the presence of water in samples of the bulked milk of small herds of cows.[2] The claims made by certain workers that the addition of low proportions of water to milk can be detected by determination of the freezing point of the sample are, I hold, scientifically unsound. Stress is laid by these workers on the relatively small range of variation in the freezing point of milk. In the cases brought under my notice the samples were samples of bulked milk from several cows, and usually no mention was given of the number of cows whose milk was bulked. Approximately the variation in the freezing point of milk ranges from 0·5° to 0·6° C., but samples have been obtained even of bulked milk where the depression is below 0·5° C. After an exhaustive study of this problem I have been unable to find any method of determining *with certainty* that water in the proportions usually quoted has been added to the milk. Those interested in this aspect of the problem are referred to the two publications mentioned above.

The composition of milk for public consumption depends upon a number of well-known factors. One of the factors

[1] *Scottish Journal of Agriculture*, 1926, vol. ix, page 351.
[2] Variations in the Composition of Milk, H.M. Stationery Office.

hitherto very largely overlooked is the number of cows whose milk is bulked. If the milk of, say, a herd of 50 or 100 cows was always bulked, there would be little fear of butter fat falling below 3 per cent. and of solids-not-fat falling below 8·5 per cent. Legislators, when they come to study the milk laws with a view to revision, should keep in mind the large number of cases of sales of milk in rural areas where only a cow or two is kept, and also that, except in large depots, the bulked milk sold to the public from cans is usually from a small number of cows, and is not the bulked milk of the whole herd. There is a greater chance of the quality of the bulked milk of a herd being much better than the quality of the bulked milk from a few cows. A summary of the results published by various workers on the effect of bulking and other factors is given in a pamphlet recently issued by the Ministry of Agriculture and Fisheries.[1] This pamphlet is well worth study by milk producers, and also by officers engaged in the administration of the law.

In order to clear the way to an appreciation of the nature of the suggestions in this article to amend the law, it seems desirable to remind the reader that the various Acts, bearing on foods and drugs, have been consolidated in the Food and Drugs (Adulteration) Act, 1928. Section II of that Act enacts that "No person shall sell to the prejudice of the purchaser any article of food or any drug which is not of the nature, or not of the substance, or not of the quality, of the article demanded by the purchaser." Section V of the Act provides that "If any person abstracts from any article of food any part of it so as to affect injuriously its nature, substance or quality, with the intent that it may be sold in its altered state without notice, or if any person sells any article so altered without making disclosure of the alteration, he shall be guilty of an offence." Section VII (1) of the Act enacts that "The Minister of Agriculture and Fisheries (and the Department of Agriculture for Scotland) may, after such enquiry as he deems necessary, make regulations for determining what deficiency in any of the normal constituents of genuine milk, cream, butter or cheese, or what addition of extraneous matter or proportion of water in any sample of milk (including condensed milk), cream, butter or cheese, or what proportion of any milk solids other than fat in any sample of butter or milk-blended butter, shall for the purposes of this Act raise a presumption until the contrary is proved that the milk, cream, butter, cheese or milk-blended butter is not genuine or is injurious to health and an analyst shall have regard to such regulations in certifying the result of analysis under this Act." The Fourth Schedule of the Food and Drugs (Adulteration) Act gives the enactments repealed, and finally Section 37 of the Act provides for the continuation of Regulations, &c., made by the Central Authority in the following terms :—"Provided that nothing in this repeal shall affect any

[1] Variations in the Composition of Milk. Miscellaneous Publications 55, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London 1929. Price 4d

regulation, registration, appointment, sample, analysis, direction, order, certificate or approval made, effected, taken or given under any of the enactments hereby repealed, but every such regulation, registration, appointment, sample, analysis, direction, order, certificate or approval shall have effect as if made, effected, taken or given under this Act." Thus under the Act of 1928 the Regulations made by the Board of Agriculture and Fisheries of 1901 remain in force. These are as follows:—

> "Where a sample of milk (not being milk sold as skimmed, or separated, or condensed milk) contains less than 3 per cent. of milk fat it shall be presumed for the purposes of the Sale of Food and Drugs Acts, 1875 to 1899, until the contrary is proved, that the milk is not genuine, by the reason of the abstraction therefrom of milk fat or the addition thereto of water.
>
> "Where a sample of milk (not being sold as skimmed, or separated, or condensed milk) contains less than 8·5 per cent. of milk solids other than milk fat, it shall be presumed for the purposes of the Sale of Food and Drugs Acts, 1875-1899, until the contrary is proved that the milk is not genuine, by reason of the abstraction therefrom of milk solids other than milk fat, or the addition thereto of water."

These Regulations set up presumptive limits for butter fat and solids-not-fat in milk, and a seller charged with an offence has to satisfy the judge in a Criminal Court that the milk he sold is genuine because he has neither abstracted milk fat nor added water to the milk he sold. My view is that these Regulations should be rescinded, and that a law specially relating to milk should be framed and introduced to Parliament. The evidence in support of a special milk law is overwhelming. There is no doubt in my mind that many local authorities in administering the present Regulations have secured the conviction of milk sellers who in fact did not perform the act of adulteration. These convictions have been secured through mistaken ideas as to what the Regulations mean. From my point of view judges have often been misled by the erroneous views of public analysts, sanitary officers, and medical officers of health alike, and by others unconnected with the administration of the law. As one example of many mistaken views, I may refer to a letter which appeared in the *County and Municipal Record* of the 14th February 1929. The writer of this letter states:—"If any one undertakes to sell milk, it is his duty to take such steps as will ensure his customers receiving a marketable article." True, but we are left to infer what he means by "a marketable article." The writer proceeds to say:—"I am strongly of opinion that a customer who receives milk which contains only 2·7 per cent. of fat is prejudiced, as it is milk far below average quality." Why is the customer prejudiced when he is supplied with milk of average quality? Are

we to infer that the writer holds that the seller must supply milk of *average* quality? What is average quality? Is it the average of 20, 30, 50, 100 or 1000 cows or the average of the whole cows in the country? Even the average found for the whole country will vary according to the time of year. This sort of special pleading misleads legal authorities and imposes injustice upon milk sellers. What the law requires of the seller is, not milk of *average* quality, but *genuine* milk. The whole trouble has arisen through the failure of the Departmental Committee of 1901 (Cd. 491) to secure sufficient and accurate data bearing on the actual variations which occur in the composition of commercial milk, and also through the failure of the Committee to interpret properly the faulty and sparse data supplied by the expert witnesses before that Committee. The Committee was misled into thinking that when milk sold to the public fell below 3 per cent. in butter fat and 8·5 per cent. in solids-not-fat the milk was almost certain to be adulterated. Now there is only one way of establishing with certainty the adulteration of milk, and that way is by producing direct evidence in Court that the milk was tampered with either by the addition of water or skimmed milk or other fluid or by the abstraction of butter fat. If milk was of constant composition, the evidence given by a public analyst of his results would be sufficient, without other evidence, to prove adulteration. But milk is well known not to be of constant composition. Legal authorities charged with the administration of the Food and Drugs (Adulteration) Act, 1928, must, however, protect the public against adulteration of milk. The only means they have at present of protecting the public in this connection is to charge the seller with a breach of the Sale of Milk Regulations, in other words to charge him with a criminal offence. My view is that the State should discriminate between genuine milk of poor quality and milk which has been adulterated. Instead of rendering the seller liable to criminal prosecution when milk is found to be poor in quality, a civil liability should be placed upon the milk-seller to supply milk of a certain minimum quality.

In my annual report to the Aberdeen County Council I have given numerous examples of bulked milk of herds of cows falling below the prescribed presumptive limits in butter fat and solids-not-fat. These samples were samples of genuine milk, the samples being taken by the officers of the County Council with all necessary precautions to secure genuineness. It is idle to hold that a seller is necessarily breaking the present law if he supplies milk containing, say, 2·7 per cent. of butter fat. If the law had stated that the seller must supply milk of *average* quality, doubtless the sale of milk containing less than 3 per cent. of butter fat or less than 8·5 per cent. of solids-not-fat would have been very promptly stopped by the proceedings taken by local authorities. Only it would have been necessary for the central authorities to define what they mean by milk of *average* quality. I do not think it possible for sellers of milk always to supply

milk of average quality, even if a proper definition were given of the word "average." The nature of the variations in the composition of milk indicates that about one-half of all samples fall below the average, and one-half rise above the average. This is a well-known phenomenon in variation in general. What could be justly asked of a seller is to give a warranty as to the quality of his milk. Under the Fertilisers and Feeding Stuffs Act, sellers are required to provide a statutory statement when a sale is made of the chief fertilisers and feeding stuffs. A seller is not liable to a criminal prosecution if the sample does not conform to the warranty given, but a civil claim may be lodged against him. I entirely dissent from the view that dairymen supplying genuine milk below the prescribed minimum limits should be brought within a criminal court. The authorities never intended that milk sellers should be subject to a criminal prosecution for supplying genuine milk of poor quality. The intention was, and is, to bring a *fraudulent* seller into a criminal court. The difficulties can be overcome by requiring a warranty from the seller both for butter fat and solids-not-fat. Milk solids other than fat are valuable food constituents, namely, proteins, mineral matter and milk sugar, and the minimum limit for the solids-not-fat warranty need not be fixed at the arbitrary figure of 8·5 per cent. Local authorities should be empowered to enter the registered premises of a seller of milk in order to test the warranties given by that seller, and to claim for any deficiency found, provided the sample was taken with all the necessary formalities. It will be evident that the civil claim should be small, when compared with the fine imposed in a criminal court upon a seller convicted of adulteration. If the officers of local authorities had legal power of entry into registered premises, they would be able to detect adulteration at its source and to make the abstraction of butter fat or the addition of water or of skimmed milk by the seller extremely difficult. One final argument in favour of the abolition of the "presumption" that milk has been adulterated, when found to fall below the present prescribed limits, is the stimulus such an abolition would have on the production of milk, and also, I hope, on its use by the public. Without doubt many honest sellers, who have been convicted in Court, have ceased milk production because of the resentment they feel at being unjustly and harshly treated in the conduct of their business. *Every encouragement should be given to increase both the milk supply and the milk consumption of the country, and to convey to milk producers the impression that the law punishes only the evildoer and not the honest man.*

INSECT PESTS.—No. VI.

R. STEWART MACDOUGALL, M.A., D.Sc.

MOTHS.

To the great section of Moths belong various species whose caterpillars—popularly called silkworms—secrete silk by means of long silk glands, the silk being spun into a cocoon under cover of which pupation takes place. The best known species is *Bombyx mori*, whose caterpillars feed on mulberry leaves. The silk passes as a fluid from the two silk glands by two tubes or ducts which meet and join into one where the silk is pressed into a thread. This thread emerges by the spinneret at the tip of the lower lip of the caterpillar, and hardens at once on exposure to the air. One of the recent chemical advances is the manufacture of artificial silk from cellulose pulp, and so successful is the work that the silkworm has been put partly out of business.

While this silkworm and allied species can be described as useful, some of the worst enemies of the farmer, the gardener, the forester, belong to the moth section of insects. The damage is done by the caterpillar. Nearly all caterpillars are vegetarians, and their business is feeding. The worst enemy in agriculture in certain areas in Canada and the United States is the caterpillar of a moth, the European Corn Borer (*Pyrausta nubilalis*). The Corn Borer, introduced accidentally to America about 1910, is now such an enemy of maize or Indian corn that great tracts of the United States and Canada are quarantined for certain parts of the year, and in the campaign against the pest uniformed inspectors patrol the roads leading from infested areas, in case by automobile and other means of transport the Borer be carried from one district to another in green corn in the cob. At the same time constant war is waged in the fields against the Borer. Again, the Bollworm—the popular name for the caterpillar of a Noctuid moth—in the United States, ranks, as an enemy of cotton, second only to the Boll Weevil; while the Pink Bollworm of Egypt—the caterpillar of another kind of moth—is a serious menace there to cotton growing.

The Potato Moth (*Phthorimæa operculella*), a scourge on potato tubers in many widely separated parts of the world, is one of the pests scheduled by the Ministry and Department of Agriculture. Fortunately it has not gained a footing in Britain, though one can be afraid that the climate of the south of England would suit it.

The moth enemies of agricultural crops in Britain are not so grievous, but in certain years some of them do considerable damage; and periodically there are plague years. We shall review the Families which, in Britain, contain the troublesome species.

The Hawk Moths (Family *Sphingidæ*).—This very interesting family of stout-bodied powerful fliers has, in Britain, little economic importance. The family is in great favour with collectors. One member, the Death's Head Moth (*Acherontia*

atropos), whose caterpillars feed on the potato plant, calls for notice, not so much for the harm done by the caterpillar—the moth is not common enough for that—as because of the size of the moth and its striking character. Moth, caterpillar and pupa have all the power of giving out sounds that have been compared to the crackling of an electric spark and the shrill squeak of a mouse. The Death's Head is the largest British moth and has a spread of wing of 4½ inches. The moth is not common in Scotland, but I have recorded it from Cromarty, Perth, Ayr, Roxburgh, Kirkcudbright, Dumfries, Argyll. The moth's common name, Death's Head, is from the yellow patch with black spots on the upper surface of the thorax, the yellow patch resembling a skull. The front wings are dark brown, with many zig-zag markings; the hind wings are yellow, with black bands towards the hind margin. There is a short thick proboscis, and the moth takes exuding sap from trees, and honey from hives it may enter; it flies at night. In South Europe, where the Death's Head is much commoner, the moth is the cause of trouble from its habit of entering hives and stealing honey. Observers on the Continent and in Britain have found the moths flying round hives, crawling over hives, and inside hives. Moths have been taken emerging from hives with their wings and legs covered with bees, and also so engorged with honey as to be unable to fly. In other cases the bees, unable to turn out the intruder, have been known to surround it with a complete covering of wax. In March 1914 in Kirkcudbright a hive of weak Italian stock was opened by the owner and the stock was found dead. A Death's Head moth was found in the hive lying between two combs. The moth, which was sent to me for determination, had lost its hair and its scales and was completely hollowed out; a dead bee was lying in the framework of the abdomen.

The caterpillar is yellow-green speckled with purple; there are seven oblique violet stripes on each side which meet on the back; the spiracles are black; from the upper surface of the second last joint a rough horn projects; the legs number sixteen. A full grown caterpillar may measure about five inches.

The caterpillar rests in the daytime and feeds at night on the leaves of potato and allied plants, and when full-grown enters the soil for pupation. The pupa is chestnut brown. Pupæ removed from the soil may prove difficult to rear; indoors they should be kept in a warm room and in slightly moist conditions.

The Owlet Moths (Family *Noctuidæ*).—This is a large family of middle-sized moths. As a rule the moths are in colour some shade of brown, though the hind wings may be gaily coloured. They fly at night or at dusk, hence the name Owlets or Noctuids. When resting in the daytime on trees, fences and withered leaves, they can be easily passed over on account of their colour so harmonising with their resting places. Members of this family come willingly to sugar or treacle, and a visit by lantern light to posts, trees, fences previously "sugared" generally results in a "catch" of

Noctuids. The caterpillars are smooth and as a rule not hairy; in most species the legs are sixteen in number; just as the adults, so the caterpillars mostly feed at night. The Noctuid family contains numerous species that are enemies of agricultural crops, and among them the moths whose caterpillars are known as Surface Caterpillars, because they shelter in the daytime in the surface layers of the soil or hidden under stones and litter. They are also known as Cutworms, from the habit some have of biting across the stems of the food plant at or below the surface of the soil. The favourite food plants are cruciferous crop plants like turnip; but they are also enemies of wheat and autumn grown cereals, and of mangolds and potatoes; cabbage and other seed beds may suffer, including nurseries of young forest trees. A selection may be made of the most troublesome species.

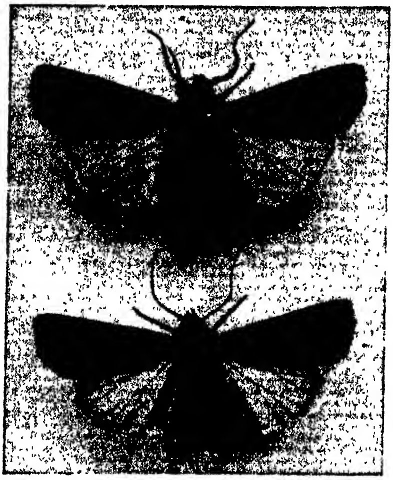


FIG. 1.

Agrotis Segetum. Natural size—male and female.

The Turnip Moth (*Agrotis segetum*). (Fig. 1.)—The front wings are brownish with a tinge of red and with various spots; hind wings white; the moth measures ¾ inch in length and up to 1½ inch in spread of wings. The two sexes are easy to distinguish; the male has double-combed antennæ and the hind wings are pearly white; the female has the antennæ simple or thread-like, and her hind wings are white but clouded at the margins.

The moths fly in June, when numbers of eggs are laid, low down on the food plant; to begin with the young caterpillars feed at the base of the plant; they also enter the soil and eat into turnips and potatoes. Some time ago I found the caterpillars busy at their destructive work on potatoes, which were hollowed out by them; the potatoes were on an experimental ground, and the caterpillars brought the experiment to an end for the season. Although attacking potatoes in this case, the caterpillars are more or less general feeders. The caterpillars of the Turnip

Moth (Fig. 2) are glossy grey or pale smoke-coloured, with a faint pale dark-edged line down the back; the spiracles, along each side of the body, are black in colour and very small—smaller than the dots or warts above and behind them; under surface of body light grey; head grey, with two dark arched lines.

While the earliest of the caterpillars may pupate in the autumn, in time for the issue of the adults in the same season, the usual thing is for the caterpillars to remain as such over the winter, and to continue feeding on succulent underground parts during open weather. Full grown in May, these caterpillars pupate and the moths come away in June. The pupa lies in the soil in an earth-cell; it is plump, yellow brown in colour, and has two small spines at the hind end.

Apart from agricultural crops, seedlings in nurseries may suffer severely from these surface caterpillars, the little plants often looking as if they had been cut across with shears.

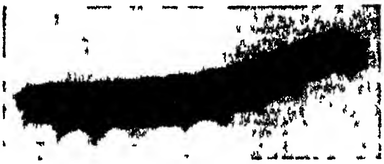


FIG. 2

Caterpillar of Agrotis Segetum. Natural size

The Heart and Dart Moth (*Agrotis exclamationis*). (Fig 3.)—This widely distributed species is closely allied to the last, which it resembles in size. The front wings are yellowish-grey or dark brown with cross lines that are not very distinct; of marks that show well one suggests a heart and there is a line-like dart, hence the common name for the moth; instead of a heart and dart others see a mark of exclamation. The two sexes are easy to distinguish; the males have the front wings light brown, the hind wings white, and the antennæ tooth-like (use a lens); the females have the fore wings dark brown, the hind wings smoke-coloured, and the antennæ simple and thread-like.

The caterpillar is very like that of *A. segetum*, but the spiracles are larger than the black warts or spots above and behind them.

The caterpillars like those of the Turnip Moth are general feeders, feeding on all kinds of garden and crop plants; they feed at night and rest in the daytime. The pupa, found in the soil, is brownish-yellow, and ends in two small diverging spines which are bent inwards at the tip. The life-history is the same as that of the Turnip Moth.

The Large Yellow Underwing (*Triphæna pronuba*). (Fig. 4.)—This is one of the commonest of our moths in summer, and must be known to many from its persistency in flying in at open windows towards lamp or other light. In Germany the common name for the moth is the House Mother, from its habit of

entering houses. Indoors it may be found in the daytime resting in some shady corner, the yellow hind wings being concealed under the slightly drawn-back fore wings. An appreciable number that come to me for determination are from bedrooms. The moth has a wing spread of 2¼ inches; the front wings vary through different shades of brown to purple and are mottled; the hind wings are yellow, with a wavy black band parallel to the hind margin but not extending to it. There are other species of Yellow Underwing Moths, but the only one as large as pronuba is the Broad Bordered Yellow Underwing (*T. fimbria*), whose hind wings, however, are deeper orange, and their black band is not only much broader but reaches the inner margin of the wing. Besides the *T. fimbria* caterpillar, though taking such low plants as primrose and blaeberry, typically feeds on the birch and other trees.

The caterpillar of the Large Yellow Underwing has a stout body and measures over two inches when full grown; the colour varies, green or yellow-green to brown; a pale line is visible running down the middle of the back; there are pale yellow or greenish side stripes; the spiracles are black or dark yellow surrounded by black; on being touched the caterpillar rolls up. The caterpillar comes under the name surface caterpillar and is a general feeder, taking a number of low plants, cultivated and wild.

The pupa is glossy red-brown and stout, with two projecting thorns at the hind end and two short prickles on the cremaster; the pupa lies in an earthen chamber in the soil.

The moths fly in June, July and August; they fly at night, resting in the daytime on low plants; the moths, if disturbed, run actively away to some other shelter place. The female lays a very large number of eggs, cream-white in colour, and crowded together, on grasses and low plants; the eggs are small for the size of the moth. The caterpillar feeds at night and hides in the daytime; it may be just into the soil under or near the food plant. The winter is passed in the caterpillar stage, and feeding in the soil continues when the weather is not too severe. Pupation follows in late spring.

Control of Surface Caterpillars—Disturb and destroy the caterpillars by harrows, in the case of young roots, and by frequent working of the soil in winter and spring. Caterpillars and pupæ escaping death by crushing are exposed to rooks, gulls, and lapwings.

Evidence accumulates as to the value of poultry against the caterpillars. Theobald[1] writes: "It was found that where both mangolds and swedes were attacked and were being rapidly destroyed by cutworms, the fowls worked round each attacked plant and soon cleared the larvæ out and so saved the crop. The value of poultry for clearing potato-land before sowing corn has also been clearly demonstrated."

[1] Research and Advisory Department, S.E. Agricultural College, Wye, Annual Report, 1920 21.

FIG. 3.
The Heart and Dash Moth and its pupa. Natural size.

FIG. 4.
Triphœna Pronuba. Natural size.

Mr. F. O. Mosely in intimating in 1921 great destruction of mangolds and potatoes and the ruining of a plot of 60,000 chrysanthemums wrote: "The greatest help proved to be in allowing fowls to range over infested land. Early in August fowl-houses were distributed over fields (three or four to six acre fields), and this, together with keeping the land clean, enabled great numbers of larvæ to be cleared out."

Potatoes should be well earthed up and this should be done early.

A favourite method of destroying the caterpillars in Canada and the United States is by the use of poisoned bran. I have the formulæ and method from Mr. Arthur Gibson, the Dominion of Canada's Entomologist.[1] The poisoned bran mixture:—

Bran, 20 lb.;
Sugar or molasses, 1 quart;
Paris Green, ½ lb.;
Water, 2 to 3 gallons.

Mix the bran and Paris Green thoroughly in a wash-tub while dry. Dissolve the molasses in the water, and wet the bran and the Paris Green with the same, stirring well so as to damp the bran thoroughly.

Fryer[2] suggests that lead arsenate might be substituted for the Paris Green at the rate of 2 lb. lead arsenate paste for every ½ lb. of Paris Green of the formula, the paste being first worked up with the water and sugar and the mixture added to the bran.

While good results have attended the poisoned bran experiments, the Ministry of Agriculture Leaflet does not quote the formula because, as is pointed out, Paris Green and lead arsenate are dangerous poisons, and the Protection of Animals Act, 1911, permits the use of poisoned bran only "where all reasonable precautions are taken to prevent access thereto of dogs, cats, fowls or other domestic animals."

Against cutworms in gardens a simple formula is:—

Bran, a quart;
Paris Green, one teaspoonful;
Molasses, one tablespoonful;

with sufficient water to moisten the bran. In gardens with rows of vegetables the mixture should be scattered thinly along the rows on either side as soon as cutworm injury is noticed.

The poison is best scattered or placed round, but not touching, flower plants, and after sundown, so that it will be in the very best condition to attract the cutworms when they come out to feed at night.

On a smaller than a farm scale handpicking the caterpillars is a practical measure. By night the caterpillars are above

[1] Transactions of Highland and Agricultural Society of Scotland, 1923. Report on Insect and other Pests, by R. Stewart MacDougall.

[2] Ministry of Agriculture, Leaflet No. 33. Collected Leaflets on "Insect Pests of Farm and Garden Crops."

ground; by day they would be found on turning over the top inch or two of soil by means of a trowel or a blunt large-bladed knife.

The Rustic Shoulder Knot (*Hadena or Apamea basilinea*).—The caterpillars of this moth are in different areas on the Continent well known as most harmful to cereals and grass crops. Till comparatively recently there were few records of damage by this species in Britain in spite of the fact that the species is widely distributed. Curtis[1] recorded it as injurious to wheat in 1846. Theobald[2] in 1905 reported on damage to cocksfoot grass in experimental plots at Rothamsted. Carpenter[3] recorded injury to barley and oats in 1906 and 1907 in Ireland; Mr. Thomas Anderson and I[4] recorded considerable damage to barley, wheat and oats at Inveresk and Longniddry in 1910 and 1911. Somerville[5] recorded damage to ears of wheat at Oxford in 1916.

In observations made on the caterpillars in the laboratory Mr. Anderson found the caterpillars feeding greedily on young plants of maize and not refusing the tenderer parts of *Bromus inermis*. At Inveresk, where Mr. Anderson was supervising experimental plots of wheat, barley and oats, he noticed that Scots bere barley was very liable to attack.

The moth has a wing spread of 1¼ to 1½ inches; the front wings are brown, varying from light to dark brown, with darker markings; the hind wings are smoky brown; the moth, however, is very variable in colour and markings.

The caterpillar is green with a yellow or light brown glossy head; two brownish or purplish-pink lines run down the back; the joint behind the head and the last joint have each a brown horny plate on their upper surface. The full-grown caterpillar measures an inch. The body is somewhat narrowed both in front and behind.

The moths are found in flight from the end of June, through July to August. Barrett describes them as "hiding in the day-time under copings of walls or in a chink of any kind, but in the vast majority of cases among grass and herbage." The moths fly at night. The eggs are laid on the ears of wheat for example, and the young caterpillars enter and spoil the grains.

The caterpillars may be found in large numbers in the granary, having been carried in in the ricks. The winter is passed in the caterpillar stage, and very commonly in the soil. In spring, feeding is renewed, and now the stems and leaves are attacked. Curtis[6] writes: "It is the habit of the caterpillar to crawl up a fresh stem of wheat about four inches from the

[1] Farm Insects, by Curtis.
[2] Report on Economic Zoology, by Professor F. T. Theobald
[3] Economic Proceedings of the Royal Dublin Society, August 1908, by the Rev. G. H. Carpenter.
[4] Insect Pests of 1911. Transactions of Highland and Agricultural Society of Scotland for 1912.
[5] A Caterpillar on the Ears of Wheat, by Professor W. Somerville. *Journal of the Ministry of Agriculture*, June 1916
[6] Farm Insects, p. 226.

ground and stop at the apex of the sheath, at which point it is expanded into the blade, where it commences gnawing a hole in the main stem with its head downwards, and in the course of a few hours thus completely buries itself in the tube of a stem, eating the main stem quite through. When the caterpillar has destroyed one stem it crawls out to attack a fresh one in the same manner. Three caterpillars thus in about a fortnight ate upwards of thirty stems."

Mr. Anderson, who watched the caterpillars in the open at Inveresk and in the laboratory, sent me the following detailed account :—" The caterpillar climbed the plant on which it wished to feed. It tested the leaf-sheath of each leaf from the base, and finally selecting the sheath of the last fully developed leaf, it pushed its way between the sheath and the developing shoot within, and passed down to the base of the sheath, where it devoured the tender meristem above the node, cutting it through completely. The presence of the caterpillar in the plant is indicated by the widening of the sheath in the last fully developed leaf, by the presence of excrement at the ligule, and by the wilting of the younger protruding leaf, which becomes yellow, and as it has been eaten through below comes away very easily." In estimating the damage Mr. Anderson wrote to me :—" In the two plots of bere and the plot of wheat where the damage was worst, from 15 per cent. to 25 per cent. of the plants were attacked, but even in these small plots the attacks were local, one larva probably accounting for the damage at one place. The plants were not completely destroyed, but recovered by tillering. The result of attack was uneven ripening and unequal ears. The attacked wheat plot had been sown from the two best ears of a plant reported as the strongest plant of all the plots of the year. In the following season this plot was the worst in tallness, uniformity and density, the latest to ear, and in all respects the poorest of the wheat plots.

In the case described by Somerville[1] ears of wheat had been attacked on small experimental plots at Oxford, and in many cases the grains had been entirely or partially emptied of their contents.

In May the caterpillars are full fed and then they enter the soil for pupation.

The Rosy Rustic (*Hydrœcia micacea*).—The caterpillars of this Noctuid moth feed in the stems and roots of horsetail dock, sedges, plantain. I have recorded it as injurious to hollyhock and also to potato plants, where it tunnels down the shaw to the tuber. The caterpillar is found from June onwards to the autumn; its colour is pinkish grey-brown or purplish-brown; the under surface is pale; all over the body is a series of black warts or dots each bearing a bristle; the pupa is yellow-brown and slim, and shows at the hind end two long and two short bristles; the pupa is found in the soil. The typical habitat for the Rosy Rustic caterpillars is the roots of succulent plants in

[1] *Journal of the Ministry of Agriculture*, June 1916.

moist places. Among crop plants it is worst on potatoes. It has been recorded by Theobald from unripe tomatoes, and recorded on the Continent from strawberry and rape.

THE following notes on the early teaching of agriculture in Orkney are communicated by Mr. JOHN MASON, M.A., Headmaster, South Queensferry Public School.

Agricultural Education in Orkney.

It is an outstanding feature of agricultural education, as far as instruction in Scottish schools is concerned, that its inception was due to the enthusiasm of schoolmasters. But for the petition presented to the Highland and Agricultural Society in 1875 by the Association of Schoolmasters in the "three northern counties," along with the warranty that one hundred and fifty dominies were prepared to teach the subject in their schools, the establishment of agriculture as a subject of systematic instruction in Scottish schools might have been delayed indefinitely.

To a schoolmaster, also, is due the credit of instituting the subject in the schools of Orkney. He was Mr. Alex. Middleton, the teacher of "Dounby Science School," an institution which for years attracted considerable notice in agricultural and educational circles by reason of its field experiments. The innovation, begun in 1886, created an interest among neighbouring schoolmasters and the farming communities of the Isles, and was largely responsible for the dissemination of scientific knowledge concerning farming in the far north.

The movement was the outcome of the increasing interest throughout Scotland in general and applied science which was fostered by grants offered by the Science and Art Department, South Kensington, for adult classes in scientific subjects.

At that time there were sixty-two schools in Scotland engaged in teaching agriculture, thirty-four of which were situated in northern districts. These were evening schools following the Science and Art Department's scheme and striving after certificates and grants in aid. But statistics show that in the northern area of Scotland alone a number of schools had instituted agriculture as a "specific" subject forming part of the day school curriculum. In 1885 no fewer than one hundred and thirteen scholars in standards IV-VI were presented for examination in the subject.

This movement in the north influenced the trend of science teaching in Orkney. In 1885 classes in magnetism and electricity had been held at Dounby. Mr. Middleton, however, realising the importance of agriculture as the subject most valuable to rural communities whose interests were directly connected with the land, obtained the qualifications necessary for recognition by the Science and Art Department as a teacher of

agriculture, and during the year 1886-7 Dounby had a class of twelve pupils, engaged in the systematic study of agriculture and undergoing a course of twenty-eight lectures covering the Science and Art Department's Syllabus. These lectures were compiled from the works of Tanner, Wrightson, Webb and Fream, and from what was current in opinion within the pages of the *North British Agriculturist*.

The system of agricultural teaching thus begun in Orkney, as in other parts, from a theoretical aspect, developed a practical application in the year 1889. At that time the Lords of Committee of Council for Agriculture were offering grants in aid of agricultural experiments, and representation having been made on the recommendation of Mr. H. Welsh, H.M. Inspector of Schools, Northern District, and of Professor Andrew Jamieson of the West of Scotland Technical College, Glasgow, Dounby Science School received a grant of £25 for carrying out experiments upon cereals and root crops. This, the only concession of its kind to schools in Great Britain, marked the beginning of a wider application of education to rural industry. The Dounby scheme of agricultural experiments linked theory to practice, and opened the view to a broader conception of agricultural teaching.

The existence of a garden one acre in extent gave opportunity to Mr. Middleton for carrying out experiments in the cultivation of such crops as "beet, sugar-beet, carrot, onion, lucerne, sainfoin, mangels, turnips, &c.," all of which were dealt with in studying the class manual. Not content with this garden thus cultivated, he rented another acre of heather-clad ground on the Dounby-Hosen Road, which, when cleared and ploughed, became an "experimental field" subsequently divided into some eight plots and sowed with oats. The plots were treated manurially as follows :—

> Plot unmanured; 2, sulphate alone; 3, sulphate and nitrogen; 4, sulphate, nitrogen and potash (one plot nitrogen in the form of nitrate of soda, another sulphate of ammonia); cereal manures supplied by local dealers.

In both garden and field, tillage was done by "horse labour" as far as possible.

In a neighbouring field on Dounby Farm Mr. Middleton carried out experiments on the tenant's turnip crop. Eight drills were dressed liberally with farmyard manure, four also receiving superphosphate and four basic slag of similar unit value. The results proved similar, although in the following year the residual effects of slag as compared with superphosphate were markedly shown upon the succeeding crop of oats in foliage colour and vigour of growth.

Following upon the institution of agriculture as a subject of instruction in evening classes at Dounby we find that the subject was also taught in the day school. This was the natural sequence of the movement in other districts in Scotland, and

was largely due to the inclusion of agriculture in the Fourth Schedule of the Scotch Code of 1883, where it was recognised as a "specific" subject eligible for special grant. The nature of the work done in the day school may be designated as more or less practical, although the outdoor work may not have given much manual training. The demonstrational plots at least yielded information regarding what was essential to rural life and industry, information which disseminated scientific notions of agriculture worthy of local criticism. The indoor experiments carried out in classroom, demonstrated the essential principles, and gave a knowledge of scientific process through contact with nature and natural environment.

The influence of the movement thus begun spread to neighbouring parts, and established an interest which affected opinion in the Isles and touched not only the farming communities but also the professional classes. In 1888 Mr. Middleton conducted a successful evening class in agriculture at Harray, and his enthusiasm brought together not only youths but also men of mature age, who came from considerable distances in order to qualify for presentation at the Science and Art examinations.

In the same year George Duthie, the headmaster of Birsay, took to the subject both in day and evening school. Unfortunately he had no garden, and the work more or less took the form of a lecture course illustrated by demonstrations and visits to neighbouring farms.

In later years, from 1890 onwards, day and evening classes were conducted at Finstown, Firth Public School, at Stenness and at Rendall by the late William M'Kay, the late Magnus Spence (author of "Flora Orcadensis" and "Standing Stones of Stenness"), the late James Omond and Fred. S. Scott respectively, schoolmasters who possessed a love of rural life, and who were notable students of botany.

Like Middleton, Omond experimented with crops on a piece of ground adjacent to his little school, while Spence and Scott toiled in the schoolhouse garden. Each was alive to the value of a correlation between outdoor and indoor work in a subject which called for scientific treatment, and the nature of the experiments attempted within the limits of a classroom reveals to what purpose and with what progressiveness they laboured at a time when H.M. Inspectors of Schools in most parts of Scotland based their adverse criticism of the subject of agriculture upon the vicious practice of the schoolmasters who followed the narrow lines of a simple text-book. The scheme of indoor experiments carried on in Orkney is illuminating. It embraced features which to-day the teachers of rural science may regard as the exclusive choice of modern education in the sphere of applied knowledge of rural industry. In it are embodied such sub-sections as germination, osmosis, transpiration, respiration, examination of plants grown on rich and on impoverished soil, &c. The direct study of these and of collected specimens culled from the

fields and from the wilds formed the basis of an education not only in the affairs of rural industry, but also in science method.

The movement in the Isles evoked criticism. Its nature and the fact that schoolmasters were responsible both for the innovation and for its progress among farming communities provoked among certain classes a type of criticism that was mildly adverse, but which resulted in nothing further than increased interest.

The main controversy seems to have centred round the Science and Art evening classes, which were carried on with a view primarily to supplementing the incomes of the teachers, but which nevertheless proved of value to those engaged in farming. It was said that attention was too largely concentrated upon the gaining of certificates and of grants, with the result that where a syllabus was prescribed there was undue straining after a knowledge of the subject through one or other of the recognised text-books. The examiners for the Science and Art examinations were Professors Wrightson and Tanner, each of whom had produced a manual. These set the papers in alternate years, so it was thought important that a knowledge of what the year's examiner had written upon the matter should be given.

The criticism may have contained an element of truth, but there is no gainsaying that the teaching was the best of its kind at a time when agriculture as a school subject was struggling under difficulties and against prejudices. The fact that criticism and newspaper correspondence were provoked among the farming classes, and that scepticism prevailed among men of agricultural experience as to the efficacy of the instruction imparted by non-farmers, was sufficient to prove that at least the enterprise of the dominies had served to arouse a larger interest in rural matters. The fact that there were youths and men of mature age willing to undergo a course of twenty-eight lectures in the winter evenings, and to suffer the task of a written examination militated against the hasty opinions of the critics. The institution of practical demonstrations, whether on a plot of ground or within the walls of the schoolroom, and the working of experiments closely related to farm occupations and rural life in general, had an uplifting influence upon community life and interests.

There is no doubt that the pioneers of the movement lived before their time, working under difficulties unknown at the present day. The work may have had its faults; it may have bristled with points upon which the apt critic could hang an adverse opinion, but it was work worth the accomplishment, because it paved the way for later teaching, and laid a basis upon which to build the superstructure of the present-day teaching of agriculture.

THE following article is taken from *The International Review of Agriculture*, May 1929.

Ultra-Violet Light and Vitamins in Poultry Management.

Vitamins and radiant energy are now recognised as important nutritional factors. The application of these newly discovered food accessories in poultry management has in recent years been the subject of a quantity of experimental work mainly in America and England, and these investigations have proved the importance of ultra-violet light, and of at least three of the known vitamins, in poultry culture and their influence on the growth of the chick, egg production and on the hatching capacity of the egg.

The value of direct sunlight in the prevention and cure of leg weakness in the growing chick has been fully demonstrated and is now an established fact.

Ordinary window glass does not allow the passage of the beneficial rays, and since the price of the special non-filtering glass now available is high it has been found necessary to search for an inexpensive glass substitute which will transmit the essential rays. Bethke and Kennard conducted experiments to test the efficiency of two types of glass substitute known as "screen glass" and "fabric glass." The former consists of a wire screen impregnated with a cellulose compound and the latter of a fabric dipped in a paraffin-like preparation. Five lots each of 21 White Leghorn chicks were confined in indoor pens. Lots 1 and 2 served as controls and received no sunlight, whilst lots 3, 4 and 5 received 30 minutes' daily exposure to direct sunlight, sunlight through "screen glass" and sunlight through "fabric glass" respectively. Each of these groups received in all 64 exposures equal to a total of 21 hours of sunlight. One half of the birds in the two "no-sunlight" groups showed signs of leg weakness by the end of the fifth week, and by the ninth week all the individuals in these two lots were affected with varying degrees of leg weakness. No leg weakness was observed in the three "exposed" groups. Experiments were also carried out to test the efficacy of light through the glass substitutes in curing leg weakness. Chickens already affected with leg weakness were exposed to sunlight transmitted by "screen glass" and "fabric glass" for 15 minutes and to ultra-violet rays from a quartz mercury vapour lamp for five minutes daily for four weeks. There resulted a general disappearance of leg weakness in all three lots as well as in the control lot, which was exposed to direct sunlight for 15 minutes daily. This experiment was conducted at a latitude of about 40°N. between March and May.

The poultry man, however, is primarily concerned with ultra-violet light in winter and early spring when the chicks are growing and the amount of sunshine is small and contains a smaller percentage of ultra-violet rays. Russell and Massengale undertook experiments to test the efficacy of sunlight during January, February and early March in New Brunswick (lat. 40° 30' N.). Four lots of five-day old White Leghorn chicks were

fed on yellow corn with sodium chloride and unlimited skimmed milk. Lot 1 was placed in a specially constructed house covered with a glass substitute. Lots 2, 3 and 4 were housed in a basement laboratory. Lot 2 was exposed at a distance of 36 in. for 15 minutes daily to the rays of a quartz mercury lamp, lot 3 was exposed similarly for 20 minutes daily and lot 4 received no treatment. The chicks were weighed individually each week and six selected for ash determination of the femur and humerus. It was found that winter sunlight at this latitude was effective in preventing leg weakness when transmitted by the glass substitute. Exposure to ultra-violet light from the artificial source was also found effective in preventing leg weakness, but the winter sunlight was slightly more effective in promoting bone formation.

An earlier experiment by Hervey at the same latitude had seemed to show that winter sunlight was not sufficient without an additional source of vitamin D, but other features of his experiment indicate that another factor, probably a mineral deficiency, was limiting bone development in this case.

Goodale's irradiation of chicks with a mercury vapour lamp for exposures varying from five seconds to three hours daily showed that, whereas 30 seconds was not adequate, one minute gave as good results as three hours. He also found that irradiation for about ten minutes twice weekly gave normal growth, while less frequent treatment was inadequate. There were some indications that prolonged irradiation retarded growth. Exposure of the *dry mash* to a mercury lamp for ten minutes favoured growth, but was not sufficient to prevent leg weakness.

Investigations have been carried out with fat-soluble vitamin D. At the California Station it was shown that leg weakness could be effectively prevented in chicks not exposed to direct sunlight if they were fed on a mash containing 2 per cent. of salmon oil made from canner refuse, including the liver.

Heuser and Norris carried out three tests with White Leghorn chicks to determine the variation in the antirachitic properties of different brands of cod-liver oil. Seven brands were selected at random, two American and five Norwegian refined oils. The cod-liver oil was mixed in the feed in the proportion of 0·5 per cent. of the ration. Each trial was of eight weeks' duration, and the chicks were confined without exposure to direct sunlight throughout each trial and were weighed individually weekly. It was found that different brands of cod-liver oil vary significantly. Thus with plenty of calcium and phosphorus in the ration the amount of cod-liver oil necessary to protect against rickets depends upon the antirachitic potency of the oil and the amount of vitamin D stored in the body of the chick at time of hatching.

Different grades of cod-liver oil were also tested. One was an American refined cod-liver oil tested biologically, another was an untested American refined oil, another a Norwegian refined oil, and the fourth a brown cod-liver oil. These oils were fed at the rate of 0·2 per cent. in both grain and mash. The results indicated that only the tested and brown cod-liver oils provided

complete protection against rickets. Bethke tested the antirachitic properties of various cod-liver meals on chicks kept in indoor pens without direct sunlight and found they also varied in ability to prevent leg weakness.

Fat-soluble vitamin A is known to be essential for growth and in the prevention of ophthalmia. Mitchell and Card found vitamin A of even greater importance for growing chicks than vitamin D. Twelve lots of chickens were fed on white corn, tankage, yeast, cottonseed oil and salt—a ration presumably low in the fat-soluble vitamins. Three of the lots received no other supplements, three received heated and aerated cod-liver oil (supplying D but not A), three received 5 per cent. of spinach (supplying A but little D), and three lots received untreated cod-liver oil (supplying both A and D). Four of the lots, one on each type of ration, were kept in a darkened room. Four similar lots were also kept in a darkened room, but received 15 minutes' daily exposure to ultra-violet light. The other four lots were allowed free access to sunlight. Those birds receiving the rations deficient in vitamin A or in vitamins A and D died off rapidly, though those having access to sunlight lived longest. Mortality was low in the other six lots, but the birds not having access to sunlight developed deformed legs and feet and other symptoms of a vitamin D deficiency. Deaths from vitamin A deficiency occurred in most cases before ophthalmia developed.

Hauge, Carrick and Prange conducted tests using yellow corn as the source of vitamin A to determine the minimum amount required. It was found that chicks fed with a vitamin A deficient ration begin to show the results in retarded growth at about four weeks of age, later develop diseased eyes and eventually die. It appeared that 25 per cent. of yellow corn was sufficient to meet their needs up to ten weeks of age, but on account of the heavier weight at laying age of the lot receiving 30 per cent. it was judged advisable to use that amount after ten weeks. All chicks received ultra-violet radiation or direct sunlight throughout this experiment, and the high mortality in the control group seems to show that vitamin A cannot be wholly replaced by sunlight.

Vitamin B, the substance which prevents development of the disease known as beriberi and appears to stimulate appetite, is found in milk, leaves, seeds, &c., and in particularly high concentration in yeast. That yellow corn with a mineral supplement as a ration for growing chicks is deficient in vitamin B was shown by Mussehl, Hill and Rosenbaum, but it does appear that there is a sufficiency in the mixed grain rations usually given. Hamilton, Card and Kick carried out some investigations in this connection. Dried yeast and dried alfalfa leaves were used as the vitamin supplements The basal ration consisted of 60 per cent. ground whole grains (maize, oats and wheat) and 20 per cent. of other seed products (wheat bran and soybean oil meal) with adequate protein, mineral and fat-soluble vitamin supplements. The dried yeast was substituted for an equal percentage

of soybean oil meal and the alfalfa leaves for bran. It was found that the addition of yeast and alfalfa leaves did not appreciably improve the ration for outdoor-grown chicks, though there was an indication that yeast improved it slightly for chicks grown in the laboratory.

Dougherty in similar experiments using dried yeast and semi-solid buttermilk as sources of additional vitamin B found that yeast stimulated the appetite of the growing chicks and consequently increased the rate of growth, but that the cost of the yeast more than offset any advantage gained. Buttermilk, on the other hand, proved a profitable growth-promoting addition to the ration.

The anti-scorbutic vitamin C does not appear to be of importance in the development of chicks.

Ultra-violet light or vitamins D and A and vitamin B have been found of equal importance for laying stock. With the object of throwing light on the causes of the comparative lack of success of the intensive system of poultry culture, Bobby carried out an experiment in 1926 which seemed to indicate that the reason for the production of confined birds being much lower than that of birds treated in every way similarly except in the matter of range, was that the confined birds were never exposed to direct sunlight. This suggested that the cause was a deficiency of vitamin D or A or both. He then carried out further experiments in which two lots of pullets fed and treated alike were confined in houses similar except that one had an ordinary board and glass front and the other a specially constructed wire netting front. To guard against inclement weather curtains were fixed on the open-fronted house which could be drawn at night, and during such times in the day as bad weather demanded. After the experiment had been in progress for six months the pullets in the glass-fronted house were divided into two lots, one of which received from then onwards 2 per cent. of cod-liver oil mixed with the grain ration. The variation between the production of the pens was so marked as to leave no doubt as to its significance, and the results obtained by the addition of cod-liver oil indicate that the oil supplied just that deficiency which was preventing normal egg production in the confined pen, in other words a vitamin deficiency which does not occur when the birds are able to receive the direct rays of the sun.

At the Wisconsin Experiment Station the influence on egg production of ultra-violet light from an artificial source was studied. Four lots of yearling White Leghorn hens were fed without access to direct sunlight on a basal ration of mixed grains and minerals with unlimited skimmed milk. One lot received ten minutes' exposure daily to ultra-violet light, and the basal ration of another lot was supplemented with five parts of dried pork liver. The experiment was started on January 1st, and by April 15th it was evident that egg production was much higher in the lot receiving the ultra-violet light treatment, and that all the other lots were suffering from rickets. After this

period one of the control lots received ten minutes' exposure daily to ultra-violet light, and the ration containing pork liver was supplemented with cod-liver oil. This change resulted in a material increase in egg production.

At the Missouri Station Kempster obtained similar results in two series of experiments. In the second the production of hens which were exposed to winter sunshine and of those given a 2 per cent. supplement of cod-liver oil was increased by approximately 100 per cent. Similarly at Ohio it was found that irradiating pullets and the feeding of cod-liver oil doubled the egg production.

At Ohio the effect of the different management of the hens on the eggs themselves was also studied. Increasing amounts of egg yolks were fed daily to rats receiving a vitamin A deficient ration, and the results showed that the eggs from pens receiving cod-liver oil and from those allowed access to sunlight were approximately five times as potent in aiding growth as the eggs from sunless pens on the basal ration. It was found also with rats on a vitamin D deficient ration that the antirachitic value of the eggs from the range pen was ten times and from the cod-liver oil pen five times as great as those from the sunless basal ration group. This result is interesting, as it indicates that the importance of ultra-violet light and cod-liver oil is not only in increasing production, but probably also in increasing the value of the eggs as a human food.

All these experiments showing the beneficial effects of ultra-violet radiation and cod-liver oil treatment on egg production apply to confined birds, and emphasise the fact that it is the supply of vitamins D and A that is essential. Mercer and Tozer's experiment on birds possessing in the winter months (even in England at lat. 52° approximately) free access to open air, sunlight and green food showed conclusively that where birds can be kept under open-air conditions with proper rations (2 oz. mixed meal, 1 oz. wheat and 1 oz. crushed maize per day + cabbage was used), including plenty of green stuff, no benefit with regard to production is obtained by feeding cod-liver oil or by irradiating either birds or food.

Various experiments have been carried out to determine the influence of ultra-violet light and cod-liver oil on breeding stock. Halpin reports that eggs from hens confined in pens where the windows were kept closed and no additional vitamin-producing treatment provided soon became practically unhatchable. Kempster found that sunshine produced in one experiment an increase of 90 per cent. and that cod-liver oil gave an increase of 30 per cent. in hatching.

On the other hand, in an earlier experiment Kempster found that the hatching of eggs from hens receiving cod-liver oil was no better than that of those from the confined control pens. And at the Ohio Station, though irradiation of pullets caused a marked increase in the hatching of the eggs, cod-liver oil exerted no beneficial effect. Goodale also obtained additional proof of the bad

hatching of eggs from hens receiving sunlight filtered through glass and the small improvement with cod-liver oil or pigs' liver. These results seem to indicate that, though cod-liver oil will replace the influence of sunlight on egg production, radiation in some form is required for breeding stock. As a matter of fact some experiments of Carrick indicate that at any rate the antirachitic quality of cod-liver oil is itself some form of direct radiant energy, since it may be transmitted through "Pyrex" flasks; but though this is of great theoretic interest it seems unlikely to become of practical use.

The influence on hatching of the irradiation of the eggs themselves has been investigated by several workers. At the Wisconsin Experiment Station it was found that exposure of eggs to ultra-violet radiation for from 1-40 minutes had no effect on their hatching, and the investigators concluded that the rays did not penetrate the shell. Dr. Fronda exposed ducks' eggs for 20 minutes daily for the first 14 days of incubation to the direct rays of the sun in the Philippine Islands and obtained a hatch of 17 per cent. in one experiment and as much as 30 per cent. in another in excess of the control. But the previous history of the eggs does not appear to have been taken into consideration, and, since it has been shown that the insolation of the hen affects the vitamin content of the egg, in the face of the Wisconsin experiments it cannot be taken as proved that direct irradiation of eggs influences their hatching.

The results of all these investigations are consistent in showing the importance of sunlight for the growing chick and for laying birds. But the proof of the possibility of applying sunshine substitutes is of even more interest in modern poultry management, in view of its two main problems, viz. the winter production of eggs, involving the winter rearing of chicks, and the keeping of a large head of laying stock upon a limited area of ground so as to ensure proximity to the good markets of an industrial centre. The winter confinement of laying stock and their total confinement, generally spoken of as Intensive Poultry Culture, have not in the past met with unqualified success. It seems to be proved, however, that the main trouble was the vitamin D and A deficiency caused in the confined birds by their deprivation of ultra-violet rays, and that the beneficial effects of these rays may be equally well produced in confined chicks and laying stock by feeding 2 per cent. of good quality cod-liver oil, in addition to a mixed and balanced ration. In the case of confined birds required for breeding, however, it seems as though cod-liver oil were insufficient, and that additional radiant energy must be supplied by direct sunlight or by artificial ultra-violet irradiation.

Craibstone.

Notes from Agricultural Colleges

Grasses and Clovers, 1929. *Red Clovers.*—About 160 samples of red clover from different parts of England and from other countries were sown in short rows, and were also included in turn as part of the same seed mixture in the field. Despite the comparatively severe winter, no plants in the row trial were thrown out by the frost. This is interesting, as in the previous winter a large number of plants of the broad-leaved type from foreign countries was thrown out, in some cases as much as 1½ inches. The reason is that during the past winter the ground was covered with snow during the hardest period.

Among late-flowering samples, 1 of English (out of 23), 2 of Montgomery (out of 21), 3 of Swedish (out of 9), turned out to be of the broad-leaved type. Ten samples of Cornish Marl, 1 of Danish (Hersnap), and 1 Norwegian were late-flowering, while 7 samples of American Mammoth were late-flowering, 2 were intermediate and 1 broad-leaved. One sample from Russia (Ural) was very similar to the Swedish late-flowering. Other 8 samples of Russian and 9 samples of Polish were broad-leaved.

It is interesting that a hare that visited the plots in late spring ate the plants of foreign broad-leaved, but in no case did it touch the English or any of the late-flowering rows. The foreign clovers were much less vigorous than the English.

In the field, as in many former trials, the plants in the plots seeded with foreign samples of broad-leaved—American, Chilian, French, Polish and Russian—were generally much scantier and less vigorous than the English samples.

In plots sown in 1927 there was a fair amount of late-flowering present, whereas there were practically no plants of broad-leaved.

In a rotation experiment part of the grain crop (barley) had been sown in 1928 after potatoes and part after turnips, the same grass seed mixture having been sown in both cases. The barley crop was much poorer after the potato crop, with the result that there was much more red clover in the succeeding grass crop. Plots of the grass were cut on 1st June this year, and the following weights were obtained in one plot where a complete artificial manure had been used :—

Previous Crop.	Weight of Green Crop 1st June. Cwt. per acre.		
	Grass.	Clover.	Total.
Barley after turnips	65	20	85
Do. potatoes	56	76	132

White Clovers.—About 20 of the plots sown in 1924 with seeds sold as wild white clover were preserved in order to study

their nature, comparative vigour and longevity. Seven of the samples are still very vigorous, six are very poor, many of the plants having died out, while in one plot there is not a single plant left. The others are intermediate.

In 1925 seed was saved from the above plots and sown in 1926. The results show that in the seven cases where the first sowing was good the once grown was also good, and that in the six poor cases the once grown was also very poor. These results indicate that cultivated seed of wild white clover is likely to produce vigorous plants if seed of true wild white is sown. Chemical tests were made of all the above samples, and in every case where a good result was obtained the seed had given a strong reaction, while all the poor samples gave either a weak or a negative reaction.

A considerable number of samples from many English counties was sown in 1927 and 1928 in rows alone and in turn as part of a seed mixture in the field. It will be sufficient to state in the meantime that in the rows there were considerable differences. While many samples, both of Kent and other counties, are vigorous, other samples have varying proportions of ordinary white present. For example, in two cases of Kent seed sold as wild white clover all the plants appear to be ordinary white, while in the case of two samples from Northampton one sample is as good as one could wish, while the other, in addition to containing some alsike clover, is mainly ordinary white. The name of the county is not sufficient to indicate the value of a sample. Each must be considered on its merits.

Many samples of New Zealand wild white clovers are also being tried. When sown in rows these usually show considerable vigour, especially during the first two seasons, but they show much less prominently in the field. In no case where the same amount of seed had been sown was the New Zealand wild white as vigorous or as well spread as from good English seed. The samples that gave the strongest chemical reaction have done best in the field, and those that gave a very weak reaction are very poor.

Previous trials had shown that ordinary white clover (English and Polish) was of little or no value in the field. As many farmers still include it in their mixtures, it was included in two plots, at the rates of 2 lb. and 5 lb. per acre respectively, a plot with wild white being sown between them. While this plot was thick with clover, there was hardly a plant in either of the other two plots.

Twelve samples of American wild white clover were sown in 1927, but all were much less vigorous than English seed.

Grasses.—An interesting feature in the hay crop was the comparatively large amount of timothy present, especially in plots where small quantities of perennial ryegrass were included. Two plots were seeded with 12 lb. cocksfoot, 6 lb. timothy, 3½ lb. red clovers, 1 lb. alsike, and ½ lb. wild white. One of the plots (B) got in addition 19½ lb. perennial ryegrass. Samples of the

hay and aftermath were separated into the different ingredients and the following are the weights of each :—

	A.		B.	
	Hay.	Aftermath (green).	Hay.	Aftermath (green).
	cwt.	cwt.	cwt.	cwt
Perennial Ryegrass ...	...	...	34·6	4·4
Cocksfoot	3·4	4·8	0·9	0·8
Timothy	28·8	7·7	3·9	1·9
Clovers	19·1	58·0	19·9	50·0
Weeds	1·0	...	1·0	...
Total	52·3	70·5	60·3	57·1

This is a remarkable result and shows very clearly why some farmers have difficulty in getting cocksfoot and timothy to grow.

As in former trials, where 13 lb. Italian ryegrass were substituted for 13 lb. perennial ryegrass in a mixture with 8 lb. cocksfoot, 4 lb. timothy and 5 lb. clovers, the yield of hay was reduced, the weights of each ingredient present being :—

	Cwt. per acre.						
	Perennial Ryegrass	Italian Ryegrass	Cocksfoot.	Timothy.	Clovers.	Weeds.	Total.
With Italian Ryegrass	..	30·3	1·3	2·9	13·3	0·3	48·1
,, Perennial Ryegrass	22·4	...	2·2	7·3	25·0	0·4	57 3

In the aftermath the weights (green) were :—

Perennial Ryegrass.	Italian Ryegrass.	Cocksfoot.	Timothy.	Clovers.	Total.
cwt.	cwt.	cwt.	cwt.	cwt	cwt.
...	24 0	2·3	4·9	47·2	75
6·0	...	4·7	1·4	60 0	75

The cows ate the plot with Italian first, again indicating that Italian ryegrass is better suited for pasture purposes than for hay production, especially as when eaten down at the beginning of the season it has not the same adverse effect on red clovers and other grasses.

In order to demonstrate the value of the late-flowering leafy strains of grasses, different samples of perennial ryegrass, cocksfoot and timothy were sown and plants of each were transplanted in the spring.

Four samples of Aberdeenshire, 2 Irish, 2 Ayrshire, and 3 English perennial ryegrasses were all somewhat similar and pro-

duced a considerable number of stalks early in the season; they were slow in forming aftermath, a few plants producing none.

Eight samples sold as evergreen or wild were tried. Two were similar to the early-flowering group, 3 were distinctly late in flowering, produced fewer stalks and formed very thick aftermath, while other 3 were intermediate. One sample from Sweden was early-flowering while another was intermediate. Jaedersk, of Norwegian origin, and Lundbeck, of Danish, were very similar and both very early flowering, and appeared as if they would be better suited for hay than for pasture.

In the case of timothy a local selection was both taller and much leafier than either American or Scots. Scots was more vigorous and leafy than American.

Danish cocksfoot was outstanding in being early in flowering and having a comparatively small proportion of leaves. German was only slightly better. New Zealand, Swedish, English and a home selected sample were all later in flowering and produced considerably more leaves.

In the hay field this year where the above samples had been sown last year the differences were quite as distinct.

Several grasses and clovers were sown alone in 1928 in plots in the field. Each plot was divided into three parts. One part got a dressing of 1 cwt. sulphate of ammonia per acre in March. It was cut in the beginning of May, June and July, and got another cwt. of sulphate of ammonia after each cutting. A final cutting was made on 20th August. The second part was cut on the same dates but got no sulphate of ammonia, while the third part also got no sulphate of ammonia and was cut in the beginning of July and on 20th August.

The following are the weights obtained :—

	Cwt. per acre (Green Weight).				
	May.	June.	July.	Aug.	Total
Perennial Ryegrass—					
With sulphate of ammonia, 4 cuts ...	25	57	28	31	141
Without sulphate of ammonia, 4 cuts ...	12	33	6	8	59
Do do 2 cuts ...	.	...	103	4	107
Cocksfoot—					
With sulphate of ammonia, 4 cuts .	12	30	52	25	119
Without sulphate of ammonia, 4 cuts ...	2	10	25	9	46
Do. do. 2 cuts ..			67	9	76
Italian Ryegrass—					
With sulphate of ammonia, 4 cuts	48	48	76	35	202
Without sulphate of ammonia, 4 cuts ...	18	20	32	24	94
Do. do 2 cuts ...	...	...	111	20	131
Timothy—					
With sulphate of ammonia, 4 cuts	9	32	46	24	111
Without sulphate of ammonia, 4 cuts ...	3	13	15	7	38
Do. do. 2 cuts ...	...	..	70	5	75
Broad-leaved Red Clover—					
With sulphate of ammonia, 3 cuts	...	82	66	28	176
Without sulphate of ammonia, 3 cuts ...	...	51	64	68	183
Do. do. 2 cuts ...	...	...	240	92	332

	Cwt. per acre (Green Weight).				
	May.	June.	July.	Aug.	Total.
Late-flowering Red Clover—					
With sulphate of ammonia, 3 cuts	...	79	79	68	226
Without sulphate of ammonia, 3 cuts ...	..	74	75	86	235
Do. do 2 cuts ...	...	...	263	58	321
White Clover—					
With sulphate of ammonia, 3 cuts	...	43	94	43	180
Without sulphate of ammonia, 3 cuts .	...	24	72	66	162
Do. do. 2 cuts ...	..	..	165	65	230

It will be seen that the effect of the sulphate of ammonia has been fully to double the amount of all the grasses. In the case of the clovers, however, the result is entirely different.

In May there was nothing to cut on any of the plots. In June there was an increase due to the sulphate of ammonia. In July they were about the same, while in August the plots without sulphate of ammonia were considerably better in all cases.

The sulphate of ammonia encouraged the annual meadow-grass in all the clover plots, and at the present time there is a considerable amount present in these parts, while there is hardly any in the parts where it was not applied.

Another interesting feature in the grass plots is that while the sole in the plots cut monthly where no sulphate of ammonia was applied is thick with natural white clover, on the plots where sulphate of ammonia was applied the natural white clover is not seen. In the plots cut twice some natural white clover is beginning to come in.

Reviews.

The Journal of the National Institute of Agricultural Botany, vol. II, No. 2, 1929.—Besides the usual reports on the behaviour under trial in plots at different centres of autumn and spring sown wheats, autumn and spring sown oats and barleys, and the awards of the Medal Committee and the decisions of the Synonym Committee in the case of potatoes, this issue of the *Journal of the National Institute of Agricultural Botany* has articles of special interest on the "Qualities for Bread-making Purposes of Wheats from the 1924-27 Trials"; the "Effects of Intensive Manuring on Two Varieties of Wheat"; and "Cereal Crops in Essex, 1926-27."

In the first of these, details are given of the elaborate method adopted to arrive at a reliable judgment in respect of quality of wheat from the bread-maker's point of view, and tables are given showing the relative merits of seven varieties grown at from four to six centres in three successive years. One remarkable feature of this comparison is the conclusion that "Dealing with the wheats now under review, grown

at the places and on the soils specified in the three years 1925, 1926, and 1927, we find no appreciable differences in quality for bread-making purposes due to differences in environment provided that the precautions stated in paragraph 2 (*g*) are observed by the millers and bakers concerned." These precautions appear to relate to the inclusion in the blended wheats, of which the flour is to be made, of a sufficient proportion of free-gassing varieties so that the dough may be thoroughly inflated. Of the seven varieties tested Yeoman II was placed highest.

The second of the special articles deals with the effects of intensive manuring on the two varieties Yeoman II and Squarehead's Master, and the conclusion is reached that given typical wheat land and a suitable variety, judicious expenditure on manures for wheat is a profitable investment even at the present low grain values. This conclusion is given merely from two seasons' work at a single centre and with two varieties only.

The article on Cereal Crops in Essex in 1926-27 describes a survey made by means of returns sent in by farmers all over the county, relating to acreage, varieties grown, seed rate, time of sowing, yields, and prices. The returns represented 3·91 per cent. of the total area of oats, 5 per cent. of the total area of barley, and 4·52 per cent. of the total area of wheat, and were from practically every parish in the county. The records made from these returns give an interesting picture of the distribution of the different varieties of cereals, and some indication of the best to grow under similar conditions of soil and climate. This method of investigating farming conditions in a particular area might be usefully extended, and, carried out year by year as carefully and methodically as this Essex investigation, it would by and by produce a collection of statistical data of great importance.

Both in form and matter the Journal is an admirable record of much good work.

The Journal of the Orkney Agricultural Discussion Society, 1929, Vol. IV, 1*s*. net.—This, the fourth volume of the Journal, is quite an imposing production in size, appearance and contents. Many a more pretentious association would be justifiably proud of a similar production, wide as it is in the general interest of its papers, and yet notably personal and direct in its appeal to the Orcadian farmer.

The variety of the menu provided may be instanced by noting that it includes articles on "Impressions of Canada," by Sir Robert Hamilton; "Sheep-Farming in Orkney," by R. Scarth; "Marketing of Live Stock and Meat," by Mr. T. G. Henderson of the Scottish Agricultural Organisation Society; "Bee-keeping"; "Securing of Hay and Cereal Crops"; "Mechanical Treatment of Grass Land"; "Care of Farm Implements"; "Income Tax"; "Advertising in Agriculture"; "Agricultural Valuations," and "Horticulture in Orkney." Divergent views are given in reports of debates on "Country *v*. Town Life";

"The Profitableness of Exhibiting at Agricultural Shows"; and "Theory and Practice."

The Society and its energetic secretary, Mr. H. H. Corner, are to be congratulated, both on their highly useful and stimulating proceedings as an agricultural force in the Orkneys, and on the excellence of the permanent record they have made in this Journal.

A most praiseworthy action of the Association in conjunction with the Orkney and Shetland Association is the encouragement given by them to the study of Natural Science by pupils under fourteen years of age attending any rural school in Orkney. The examination was held on a prepared syllabus of study, and the papers are stated to have reached a high standard. This effort to promote interest in science on the part of young people in country surroundings is worthy of imitation.

The Crop-Grower's Companion. J. Porter. Gurney and Jackson, London: 8*s*. 6*d*. net.—The title of this book is somewhat misleading, for while it contains a great deal of miscellaneous information on matters connected with cultivation and manuring, actual details relating to crops are not a special feature. Indeed the main farm crops are treated in a very summary way, and the ordinary crop-grower is hardly likely to make a companion of the book. It does contain much useful general information on miscellaneous subjects, ranging from alchemy and chemistry, geology and physics, to entomology, mycology and arithmetic, but it is more a collection of material for reference than a text-book for systematic study. The sections relating to pastures and meadow-land are perhaps the most satisfactory.

Fütterung der Haustiere, by Professor Nils Hansson. Translated into German by Dr. Franz von Meissner. (Theodor Steinkopff, Dresden, 1929).—The new German edition of "Husdjurens Utfodring" will be welcomed by those admirers of Professor Hansson's work who can read German better than Swedish. In 263 pages this book covers the whole subject of animal nutrition—general principles, feeding stuffs and foddering of cattle. Considerable space is devoted to vitamins and the mineral requirements of cattle get some attention, there being a special table also showing the acidity or alkalinity of the ash of feeding stuffs. The chapter on the production values of feeding stuffs covers starch equivalents for fattening cattle, fodder units for milch cows, barley values for fattening pigs, relative values of feeding stuffs for horses and nett energy values. In the fattening of oxen 1 kg. fodder unit is equal to 1·65 therms or 0·7 kg. of starch equivalent. These figures enable us to compare the Hansson, Armsby and Kellner feeding standards. In the last section of the book feeding standards for all classes of cattle are given and specimen rations. A special section deals with the feeding of poultry. Finally there are tables of feeding stuffs and feeding standards. In the preface Dr.

Wiegner of Zurich tells us that the value of Professor Hansson's work is recognised in Germany, and that the University of Rostock awarded him an honorary doctor's degree in 1925.

A fair idea of the scope of this book can be obtained from notes which have appeared in this JOURNAL. In October 1920 a method of calculating the fodder unit value of foods for cows is given together with feeding standards. In April 1921 the values of feeding stuffs for pigs and horses are given and feeding standards. In January 1923 feeding standards for ewes are given. In October 1923 the relation between therms, starch equivalents and fodder units is discussed. Swedish pasture-control experiments are reported April 1924, and in January 1925 the best amount of roots for cows and the concentration factor in rationing.

Women's Rural Organisations.

BELGIUM will celebrate in 1930 the centenary of her foundation as an independent kingdom by holding International Exhibitions at Antwerp and Liége. In connection with these exhibitions there will be several meetings of special interest to women. One of these is the Fourth International Congress on Family Life and Education, with reference particularly to rural family life. This Congress will take place at Liége, and the date at present fixed is 4th to 7th August 1930. Further particulars may be obtained from Mlle de Vuyst, 22 Avenue de l'Yser, Brussels.

There will also be held at Antwerp an International Congress of Women's Rural Organisations. Women's Rural Institutes have made remarkable progress in Scotland during the last twelve years, and similar organisations have been growing rapidly in other countries. Great Britain has now over 4,300 Women's Institutes, Belgium has 950 "cercles de fermières," and prosperous movements of the same kind exist in Canada, Australia, the United States, Poland, Czecho-Slovakia and Japan. It is roughly estimated that there are in the world 24,000 such bodies, with over a million members. It is hoped that complete statistics will be obtained in connection with the forthcoming Congress, further particulars of which may be obtained from Mlle Etien, 6 rue Tasson-Suel, Brussels.

Agricultural Produce (Grading and Marking) Act, 1928.

Scotch Beef.—This Act, the provisions of which were described in the JOURNAL for October 1928, confers upon the Department of Agriculture for Scotland the power to make regulations prescribing "grade designations" to indicate the quality of any article of Scottish agricultural or horticultural produce, and a "grade designation mark" (National Mark) which, in conjunction with alternative words, will represent such "grade designations." So far the Depart-

ment have applied the provisions of the Act to eggs and tomatoes produced in Scotland, particulars of the relative statutory regulations being given in the JOURNAL for July 1929.

In co-operation with a committee of representatives of slaughterers in Aberdeen and district the Department have now completed arrangements for the inauguration of an experiment in the grading and marking of Scotch beef, and have made the Agricultural Produce (Grading and Marking) (Beef) (Scotland) Regulations, 1929, prescribing grade designations (" Select " and " Prime ") to indicate the quality of the carcases of cattle killed in Scotland. The quality indicated by these grade designations is defined in the Regulations as follows :—

> " *Select.*"—A steer or maiden heifer beef carcase having excellent conformation, finish and quality, which are broadly indicated by the following characteristics.
>
> The carcase should be relatively short and stocky and heavily and uniformly fleshed. Rounds, loins and ribs should be extremely well developed and rounded. Chucks and plates should be unusually thick, compact and heavily fleshed. The neck should be very short and plump; shanks short and exceptionally well muscled. The superior muscular development of the round, extending well down towards the hock joint, should yield much beyond the average proportion of flesh in that cut. The spinal processes of the chine bones should terminate in fresh pinkish white cartilages. The same should be true of the breast bones.
>
> The finish should be ideal, fat being neither excessive nor deficient. The exterior surface of the carcase, including shanks and neck, should be entirely covered with smooth fat that is not excessively thick or wasty at any point, the greatest breadth, which should not exceed three-quarter inch, being over the loins and ribs; the interior walls should be well-covered. Cod fat, or, in the case of a maiden heifer, udder fat, and kidney, aitch and other interior fats should be abundant, but not excessive, also firm and ripe.
>
> The flesh should be firm, velvety, very finely grained and of a light rosy or cherry red colour, and in the thicker cuts should possess an abundance of marbling.
>
> " *Prime.*"—A steer or maiden heifer beef carcase having good conformation, finish and quality, which are broadly indicated by the following characteristics and are, in all respects, somewhat above the average.
>
> Rounds should be reasonably thick and heavily muscled; loins and ribs should be moderately full and plump. Chucks and plates should be broad and moderately thick. The neck should be moderately short and thick.
>
> The fat covering should extend well over most of the exterior surface, and generally be firm and smooth, but may be somewhat patchy, especially over the rumps, loins, ribs and shoulders. The neck and lower part of the rounds,

shoulders and shanks generally may have little fat covering. Cod fat, or in the case of a maiden heifer, udder fat, and kidney, aitch and other interior fats may be either in moderate supply or somewhat excessive. Interior walls of the fore-quarters may be only partially covered. Usually the fat should be firm, brittle and reasonably white, but may have a slightly higher colour.

The flesh generally should be moderately firm, the colour ranging from a light cherry red to a slightly darker red. The " eye " of the rib and loin should be above the average in thickness. Some marbling should be present in the thicker cuts.

The regulations also prescribe " grade designation marks " consisting of the words " Select Scotch Killed " or " Prime Scotch Killed," which, together with a map of Scotland inside a circle flanked by a large " S " or " P," will represent the " grade designations " " Select " and " Prime " respectively.

The Department propose, as an experiment, to appoint official graders who will attend at the slaughterhouses at Aberdeen and other centres in that neighbourhood for the purpose of grading and marking beef carcases prior to despatch to Smithfield market. The scheme is a voluntary one, and slaughterers, dealers and others in that vicinity who may be desirous of availing themselves of the opportunity of having their supplies graded and marked by an expert, who will have first-hand knowledge of the London market, are being invited to communicate with the Department in the matter.

Inspection and Certification of Black Currant Bushes, 1929.

THE Department of Agriculture for Scotland inaugurated this year a scheme for the inspection and certification of stocks of black currant bushes grown in Scotland and intended for sale. A press notice was issued on 1st May last and a memorandum explanatory of the scheme was sent to trade associations and growers.

Fees on the following scale were charged in respect of inspections undertaken by the Department :—

For any number of bushes—

Not exceeding	5,000	... ...		£1
Exceeding	5,000	but not exceeding	10,000	£1, 10s.
Do.	10,000	do.	20,000	£2
Do.	20,000	do.	40,000	£2, 10s.
Do.	40,000	do.	60,000	£3
Do.	60,000	do.	100,000	£3, 10s.

An additional 10s. for every 50,000 or part of 50,000 bushes in excess of 100,000.

Inspections have now been completed in respect of the applications received. In all approximately 187,500 bushes were in-

spected, for 87,431 of which certificates were issued. Certification of bushes followed the group classification adopted by the East Malling Research Station, viz. :—I, French; II, Boskoop Giant; III, Victoria or Goliath; and IV, Baldwin.

The certificates issued as a result of the inspections relate solely to the purity of the stocks and their apparent freedom from reversion, and are not to be regarded as guarantees of complete freedom from disease. Care was taken, however, not to certify stocks which were found to be obviously unhealthy or lacking in vigour. Certificates are valid only up to 30th April 1930, and growers to whom they have been issued have given undertakings that they will be used only in connection with the bushes actually inspected and certified by inspectors of the Department.

Guide to Current Official Statistics, Volume VII.

THE seventh volume of the *Guide*, dealing with statistical publications issued during the year 1928 by Government Departments in Great Britain and Northern Ireland, has recently been issued. The *Guide* consists of two parts, an elaborate subject index covering statistical matter of all kinds, and a numbered list of publications arranged under the names of the Departments responsible for them. The serial number of each publication is given under the appropriate heads and sub-heads of the subject index, which itself contains a large number of cross references. Thus the sources of information on any subject can be rapidly ascertained. Copies may be obtained from H.M. Stationery Office, 120 George St., Edinburgh, either directly or through any bookseller, price 1*s*., or by post 1*s*. 4*d*.

Agricultural Returns, 1929.

THE Preliminary Statement of the Agricultural Returns taken in Scotland on 4th June 1929 shows that the total area under crops and grass amounts to 4,660,000 acres, comprising 3,112,000 acres of arable land and 1,548,000 acres under permanent grass. The total acreage is the smallest recorded since 1876, while the area of arable land is the smallest recorded since the Returns were first taken in 1866, being less than in 1928 by 21,000 acres. The area under permanent grass has, however, increased by 16,000 acres, and the diminution in the total area under crops and grass is thus 5,000 acres.

The area under rotation grasses and clover, 1,499,000 acres, has decreased by 8,000 acres, while the area under other specified crops is 13,500 acres less than in the preceding year.

The total decrease is mainly accounted for by wheat, barley,

turnips and swedes, sugar beet, rape and vetches, tares, &c., which combined show a diminution of 20,900 acres. Oats, mixed grain and potatoes show increases, amounting in all to 7,400 acres.

The area under wheat, 53,000 acres, is less than in 1928 by 5,000 acres; that under barley, 104,000 acres, is the smallest ever recorded, and is less by 8,000 acres than that of last year, while that under oats, 884,000 acres, is 6,000 acres more than in 1928. The area under turnips and swedes shows a decrease of 4,000 acres, while that under potatoes is 145,000 acres as compared with 144,000 acres in 1928. Sugar beet, with an area of 1,000 acres, shows a decrease of 1,300 acres, or 56·5 per cent., as compared with last year's area of 2,300 acres. Rye, beans, peas, mangolds, cabbage, small fruit and the area under bare fallow are unchanged. Minor crops for which returns are made, but which are not separately shown in the accompanying table, all show slight increases in area.

Of the area under permanent grass, 173,000 acres were cut for hay and 1,375,000 acres were grazed, while of the area under rotation grasses and clover, 406,000 acres were cut for hay and 1,093,000 acres were grazed. The areas under permanent grass for mowing and under rotation grass for mowing were greater than in 1928 by 7,000 and 5,000 acres respectively; the total area cut for hay is thus increased by 12,000 acres.

The live stock returns show that horses, sheep and pigs have all diminished in number, while cattle have slightly increased.

Horses used for agricultural purposes, numbering 124,300, are fewer by 1,600, the total being the smallest on record. Unbroken horses of one year and above are fewer by 500, or 3·1 per cent., but foals show an increase of 100, or 1·8 per cent. The decrease in horses of all kinds is 2,400, or 1·4 per cent.

The total number of cattle, 1,224,300, shows an increase of 10,500, or 0·9 per cent. The number of cows in calf but not in milk, heifers in calf, bulls being used for service, and calves are all less than in 1928, but the remaining classes show increases. Cows in calf but not in milk and heifers in calf are fewer by 1,800 and 700 respectively, while cows in calf show a small increase. Bulls being used for service are less than in 1928 by 100, and calves by 7,400, while both classes of feeding cattle (yearlings and two years and above) show increases of 7,800 and 11,900 respectively.

Ewes, which number 3,245,900, are below the record figure of 1928 by 29,300. The total of lambs, 3,188,400, is less than in 1928 by 28,900, and that of other sheep one year and above by 23,700, but rams have increased by 900. The total number of sheep, 7,497,700, shows a decrease of 81,000, or 1·1 per cent., as compared with the total in the preceding year.

Pigs, which total 159,700, show a decrease of 35,800, or 18·3 per cent. The number of sows is less than in 1928 by 4,300, and that of boars by 300, while other pigs show a decrease of 31,200, or 18·3 per cent.

AGRICULTURAL RETURNS FOR SCOTLAND, 1929.

PRELIMINARY STATEMENT for 1929, compiled from the Returns collected on 4th June and comparison with 1928. The figures for 1929 are subject to revision.

CROPS AND GRASS.

Distribution.	1929.	1928.	Increase.		Decrease.	
	Acres	*Acres.*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
TOTAL AREA (excluding WATER)	19,069,403	19,069,403	..	..	..	..
TOTAL ACREAGE under all CROPS and GRASS (a)	4,660,000	4,665,000	..	..	5,000	0·1
ARABLE LAND	3,112,000	3,133,000	..	..	21,000	0·7
PERMANENT GRASS (a) — For Hay ..	173,000	166,000	7,000	4·2	..	..
PERMANENT GRASS (a) — Not for Hay ..	1,375,000	1,366,000	9,000	0·7	..	..
PERMANENT GRASS (a) — TOTAL ..	1,548,000	1,532,000	16,000	1·0	..	..
Wheat	53,000	58,000	..	..	5,000	8·6
Barley (including Bere)	104,000	112,000	..	..	8,000	7·1
Oats	884,000	878,000	6,000	0·7	..	..
Mixed Grain	1,700	1,300	400	30·8	..	..
Rye..	3,100	3,100	..	..	..	..
Beans (to be harvested as Corn)	3,100	3,100	..	..	..	..
Peas	300	300	..	..	..	..
Potatoes	145,000	144,000	1,000	0·7	..	..
Turnips and Swedes	374,000	378,000	..	..	4,000	1·1
Mangolds	1,200	1,200	..	..	..	..
Sugar Beet	1,000	2,300	..	..	1,300	56·5
Cabbage	4,300	4,300	..	..	..	..
Rape	9,600	11,600	..	..	2,000	17·2
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	11,200	11,800	..	..	600	5·1
Small Fruit	3,000	3,000	..	..	..	..
RYE-GRASS and other ROTATION GRASSES and CLOVER — For Hay	406,000	401,000	5,000	1·2	..	..
RYE-GRASS and other ROTATION GRASSES and CLOVER — Not for Hay ..	1,093,000	1,106,000	..	..	13,000	1·2
RYE-GRASS and other ROTATION GRASSES and CLOVER — TOTAL	1,499,000	1,507,000	..	..	8,000	0·5
OTHER CROPS	3,700	3,200	500	15·6	..	..
BARE FALLOW	5,800	5,800	.	..	..	..

LIVE STOCK.

	1929	1928	Increase		Decrease	
	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding)	124,300	125,900	..	..	1,600	1·3
Unbroken Horses (including Stallions) — One year and above ..	15,500	16,000	..	..	500	3·1
Unbroken Horses (including Stallions) — Under one year ..	5,600	5,500	100	1·8	..	..
TOTAL	145,400	147,400	..	..	2,000	1·4
Other Horses	17,900	18,300	..	..	400	2·2
TOTAL OF HORSES	163,300	165,700	..	..	2,400	1·4
Cows in Milk	356,900	356,100	800	0·2	..	..
Cows in Calf, but not in Milk	49,000	50,800	..	..	1,800	3·5
Heifers in Calf	51,600	52,300	..	..	700	1·3
Bulls being used for Service	16,900	17,000	..	.	100	0·6
Other Cattle :—Two years and above ..	206,000	194,100	11,900	6·1	..	..
,, ,, One year and under two ..	298,300	290,500	7,800	2·7	..	..
,, ,, Under one year	245,600	253,000		..	7,400	2·9
TOTAL OF CATTLE	1,224,300	1,213,800	10,500	0·9	..	..
Ewes kept for Breeding	3,245,900	3,275,200	..	..	29,300	0·9
Rams to be used for Service in 1929	91,400	90,500	900	1·0	..	..
Other Sheep :—One year and above . ..	972,000	995,700	..	..	23,700	2·4
,, ,, Under one year	3,188,400	3,217,300	..	..	28,900	0·9
TOTAL OF SHEEP	7,497,700	7,578,700	..	..	81,000	1·1
Sows kept for Breeding	17,900	22,200	..	..	4,300	19·4
Boars being used for Service	2,200	2,500	..	..	300	12·0
Other Pigs	139,600	170,800	..	..	31,200	18·3
TOTAL OF PIGS	159,700	195,500	..	..	35,800	18·3

(a) Excluding Mountain and Heath Land used for grazing.

Agricultural Conditions.

The weather during June was generally favourable for live stock, but the progress of crops, although generally satisfactory, was retarded to a certain extent during the last fortnight by cold drying winds and low night temperatures in many districts. In several localities more rain was needed, especially for turnips and pastures; in Skye, however, the weather was mostly showery, with a total rainfall of 4½ inches for the month. During July the weather was dry and sunny in most districts, and a moderate rainfall towards the end of the month proved beneficial to crops, pastures and stock. In the Outer Hebrides, however, rain was rather frequent during the month, and work on the hay harvest was retarded, while in Skye there were only six dry days and comparatively little sunshine. In Berwick heavy rains at the end of the month caused some damage to the barley crop and also interrupted the hay harvest. In practically every district the weather during August was very unsettled, with frequent heavy rain and little sunshine. Some damage was caused to crops and live stock by a violent thunderstorm in Central Aberdeen, and in several of the south-western districts thundery conditions also prevailed. In Skye the month was the wettest recorded for 20 years. The ripening of cereals and the stacking of hay were generally retarded by wet weather, and lodging of grain was prevalent in a number of districts. Turnips and pastures, however, improved generally, and live stock made good progress in most districts.

Wheat made good progress, and at the end of July was generally healthy and vigorous, especially in the south-western districts. In some parts of Perthshire, however, the crop had been badly lodged by the heavy July rains. During August ripening in some areas was retarded by the heavy rains. Cutting began by the end of the month in a few isolated cases, but harvesting was not general until early in September. The estimates of produce indicate that a full average crop is anticipated. In South-West Fife and Berwick, however, it is thought that the yield will be somewhat below normal.

Barley is a healthy and promising crop in practically every district, despite a certain amount of lodging in several of the eastern areas. The crop has ripened more rapidly than wheat, and in a number of districts a good beginning had been made with cutting by the end of August. The estimates of yield are very satisfactory. In several of the East Coast districts and in Kintyre a yield of 10 per cent. or more above the average is expected, while in South-West Angus, Caithness, Ross, North Argyll it is thought that a yield of about 5 per cent. above normal will be obtained. Only in the Lothians and Dumfries is the yield expected to fall short of that of an average season. Bere progressed well, and in the majority of districts where it is grown the yield is expected to be from 5 to 10 per cent. above the normal. Cutting was general before the middle of September.

Speaking generally the oat crop made satisfactory progress

during August. In the more forward districts the crop had ripened quickly and harvesting had begun on some early fields before the end of the month. Damage from lodging was on the whole less serious than was anticipated. The estimates of produce are very satisfactory; in North and East Perth, Caithness and Lewis, a yield of 15 per cent. above the average is estimated, and in most of the Northern, North-Eastern and North-Western districts it is thought that the yield will be 5 per cent. or more over normal. In South-West Perth, South-West Fife, Berwick and several South-Western districts, however, the ultimate yield is expected to be somewhat below the average.

Beans were generally reported to be healthy and vigorous, and in practically every district the plants have podded well. In the Southern districts of Perth and in Fife, Stirling and Renfrew it is estimated that the yield may be 10 per cent. above the average.

Potatoes made uninterruptedly good progress, and there is every indication of an excellent harvest. In most districts the crop was free from disease, but blight appeared in North and East Fife, Inverness and Nairn during August, and was also somewhat prevalent in Dumbarton and several South-Western districts towards the end of the month. In North, East and South-East Perth, Roxburgh, Selkirk, Shetland, the Outer Hebrides and Stirling the yield is expected to be about 15 per cent. above the normal, and in the majority of the other districts a yield of from 5 to 10 per cent. over the average is anticipated. In no case is the estimated figure under the average.

In practically every district turnips and swedes made good progress during August and were generally healthy and promising well. Finger-and-toe was prevalent in a number of districts, although not to any serious extent, except in South-East Perth, where the crop was reported to have been half destroyed in some fields. In Central Perth a good deal of canker was observed, while the appearance of red shank weed was reported from Central Argyll. A full average yield is expected in most areas, and in several cases the estimate is well above the average. Mangolds are generally described as a healthy crop, and it seems probable that the yield will be well up to average. Sugar beet has shown good growth. A report from Berwick at the end of August stated that part of the crop had " bolted."

As a consequence of disease the yield of strawberries in South-East Lanark was estimated at 20 per cent. below the average, but in North-East Fife despite lack of rain the crop was well over normal. In South-East Perth the raspberry crop was above the average, and in Dumbarton there was a large yield of small fruits. Owing to the lack of sunshine during August tree fruits ripened slowly. In South-East Lanark the yield was about 10 per cent. over the average; in Kincardine, however, fruit is scarce, and there is a good deal of mildew on some of the trees, while in Dumfries the crop of apples and pears is under the average.

General improvement in pastures was noted during July. In

some of the northern and north-eastern areas pastures were growing bare during August, but elsewhere grass was still plentiful. Grazing cattle throve well; dairy cows also made good progress, and the milk yield was generally well maintained. Sheep on arable and hill farms made good progress generally.

In most districts bee stocks are reported to be healthy. The rains during August were detrimental to the progress of weak stocks. In most districts the yield of clover honey was quite satisfactory; the yield of heather honey was, however, reduced by bad weather and the prospects are not good.

The supply of both regular and casual workers has been adequate for requirements; the supply of Irish labourers was, if anything, in excess of the demand.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh

CROPS AND SEEDS.

A Study of Variations of Marquis Wheat in relation to different Spacing of Plants. *By George Earl DeLong Scientific Agriculture, Vol IX, No* 5.—The following are among the conclusions reached by the author :—The tiller of the Marquis wheat may be very variable in length and maturity. While the earliest maturing tillers are usually taller, certain later maturing tillers, when environmental conditions are favourable, may grow so much taller than other tillers on the same or adjoining plots that they at once raise a doubt in the mind of the observer as to their parentage The heads of Marquis wheat plants, when grown under varying environmental conditions, show a wide range in length, shape, density and general appearance They may vary so much that it would be difficult for any one not intimately acquainted with the Marquis type to identify heads grown under different environmental conditions as being genuine Marquis.

Our Field Plot Technique with Potatoes. *By L E. Kirk, University of Saskatchewan, Saskatoon Extract from Scientific Agriculture, Vol. IX, No* 11, *July* 1929.—A statistical analysis of the results obtained in field plot experiments with potatoes was studied by the writer to find the relative amount of error due to soil differences which might be expected from the use of different plot sizes, different numbers of replications and different methods of plot arrangements, including the Latin square. Replication was found to be approximately twice as effective as increasing the length of the row Compared with a single plot test, four systematically distributed plots reduced the variability about 50 per cent The results obtained from plots distributed at random in a Latin square were compared with those obtained from plots arranged in the usual systematic distribution. Compared with 132 foot row plots and four replicates of each the Latin square method of planting gave a probable error which was 27 per cent. lower.

ANIMAL BREEDING.

Cattle.

Current Trend in World Cattle Production. *Armour's Monthly Letter, Chicago, July* 1929.—To those who read Sir William Haldane's article in *The Times* and the discussion which has followed, this letter forms an interesting

addition. Armour's experts state that the recent downward movement in the world's cattle numbers is only temporary, for, since beef prices are now established on a definitely higher level, the numbers will adjust themselves shortly. Nevertheless they state that at the present time cattle prices have advanced to a point well above the general price level, and that there is no immediate prospect that this position will be markedly disturbed.

The figures in this letter show that the numbers of cattle in all the principal countries have been steadily decreasing since 1921 with one exception, Canada, which since 1926 shows an increase of about 8 per cent. In 1921 the Argentine production was more than 140 per cent., taking the average of 1909-13 as 100 per cent. Since then it has steadily decreased till it stood in 1927 at about 115 per cent. The information upon which Sir William Haldane based his articles shows very considerable slaughterings in the Argentine, and particularly of females, in the last two years. There is an indication of an increase in numbers in the U.S.A. during the present year, while that of Great Britain shows a steady, though slight, increase in 1927 to 2¼ per cent. above pre-war figures.

The authors state that the world's production of cattle as compared with sheep is at a point which corresponds with the level of sheep production five years ago. The recovery in cattle numbers, however, will not be so rapid as was the corresponding slump in sheep production.

Figures are given showing the number of cattle per 1,000 head of human beings for the periods 1909-13 and 1920-25 respectively. They are as follows :—

	1909-13.	*1920-25.*
Great Britain	263	253
Total Europe, ...	242	217
U.S.A.	638	619
Canada	909	1,093
Argentine	3,460	4,260
Australia	2,532	2,536
New Zealand	1,886	2,643

The experts wisely point out that improvement in the type of cattle, particularly in the direction of early maturity, enables a smaller cattle population to produce as much beef. For this reason it will not be surprising if the *per capita* figures show a gradual trend downwards in future years.

Following on the publication of this letter Sir William Haldane writing to *The Times* on August 19th stated that the increase in the U.S.A. cattle population in 1928 was more apparent than real, being entirely the outcome of the increase in the number of cattle imported to the States, which has now risen to over half a million, largely from Canada. Sir William further pointed out that while there had been a slight increase in dairy cattle there had been a further shrinkage of beef, though somewhat less marked than in 1927, and concluded that the States were perhaps reaching the turning point.

Continuing, Sir William Haldane drew attention to the decreases in Great Britain (70,400 in England and a decrease in Scotland of 7,400 calves), in Ireland (North and South), as well as in the Argentina. In the latter place the sheep stock is increasing. Sir William pointed out that the retailers in this country took a profit of 2¼*d.* per pound more on home grown than imported beef, thus giving a bounty to the overseas producer. He concluded :—" It is obvious that the highly organised importing trade, which does not hesitate to invade the retail markets, itself is able through its own business acumen to compel the butchers to give a substantial preference to foreign beef at the expense of home producers and consumers."

Inheritance in Dairy Cattle. *Illinois Station Report,* 1928.—There are many points of interest to dairy breeders in this report.

W. W. Yapp found in the cross of Guernsey by Holstein that the inheritance of milk yield, percentage of fat content, percentage of protein, and percentage of ash in milk are controlled by the combined influence of a number of separately segregating units. The percentage of lactose in the milk was so nearly the same in the two parental breeds that its segregation could not be demonstrated.

Work was also done on colouring matter in the milk of the Guernsey and Holstein breeds which showed considerable breed differences. The cross breds of the first and second generation were intermediate between the parents in trend, with a slight inclination toward the amount of pigment in the milk of the lower pigmented parent. It appears that the colour, like other characteristics of the milk, is influenced by a number of factors, no one of which is dominant, though there is a suggestion that Holstein type of colour may be dominant.

Roberts and Yapp found no preponderance of one sex in the offspring of a sire. They stated the sex ratio of 8,196 dairy and beef cattle showed that there were among the Holsteins 94·6 males per 100 females, among the Ayrshires 96·0, Guernseys 80·6, Jerseys 106·1, and Herefords 101·8. The results showed no evidence that a given sire produced a great preponderance of one sex in his offspring.

Campbell shows that the size of fat globules in milk decreases as the lactation period progresses. There was no relation between the times when the fat globules of different cows showed their greatest decrease.

Gaines shows that persistency of lactation is a definite character, and he has developed a slide rule specially designed to save time in calculating persistency values. Preliminary comparisons show that persistency in fat percentage with advance in lactation is more a definite character of the individual cow. He also describes an instrument which measures the rate at which cows milk. A preparation claimed to stimulate milk secretion has been tried without any observed effect.

How to select against Bulldog Calves in Cattle.—1. A possible means of Selection for Non-Deformity Breeding in Dexter Cattle, *by Walter Landauer, Veterinary Journal* (1929), *pp.* 11-15. **2. Studies in Chondrodystrophy. IV. Differential Blood Counts of Chondrodystrophic Chicken Embryos and of Dexter Cattle,** *by W. Landauer and Laura Thigpen, Folia Hæmatologica* (1929), *pp.* 1-13 + *plate.*—Professor Crew has shown that occurrence of bulldog calves in the Dexter breed of cattle is due to hereditary factors, and that it is possible by wise selection to avoid those strains which throw these deformities. If Dr. Landauer's results are correct, and there is every reason to believe in them, then the task of selection is easier, for an analysis of the blood will give indication of those animals which are likely to be parents of deformed calves. Certain cells called eosinophiles have their origin in the marrow of the long bones of the extremities, the part of the skeleton which is most affected in bulldog calves. Under normal conditions it has been well proven that these form about 5 per cent. of all the white blood cells. In those cattle which have thrown bulldog calves the writer found that the number of these cells had greatly increased, from 10·5 per cent. to 21·7. In the case of two bulls which had been specially selected for non-deformity breeding the average count was only 2·1 per cent.

It therefore appears that it is now practical virtually to prevent the occurrence of these monstrosities. As a start, till further information is available, it might be sufficient to test only the bulls used in the herd, and it might be taken as a wise course not to use a bull with an eosinophile count exceeding 7·5 per cent. It is not difficult for a competent veterinary surgeon to make the required analysis, and the Animal Breeding Research Department, University of Edinburgh, will be glad to assist any breeder who wishes to adopt this line of action. Breeders should communicate with Mr. Buchanan Smith.

In conclusion it may be stated that it is possible that the best show types have as a rule the largest number of eosinophiles and are therefore most likely to throw monstrosities. This, however, is not invariably the case, for the two bulls mentioned above with the low counts were respectively second and third in their classes at the Show of the Royal Agricultural Society of England.

Sheep.

The Inheritance of a Lethal Muscle Contracture in the Sheep. *By J. A. Fraser Roberts.* 1929. *Jour. Genetics, Vol.* 21, *pp.* 57-68.—The condition is fairly obvious if looked for, but might be overlooked; the lamb is nearly always dead; the limbs of the lamb are rigidly fixed; sometimes only one pair of limbs is fixed, and sometimes the limbs are fixed in queer positions, thus causing difficult parturition, which almost always occurs; the lambs may be of either sex; in twins one may have the deformity, but seldom are both affected.

The condition is inherited, probably as a simple recessive. It probably occurs in most breeds. Should it be noticed in any flock the ram as well as the ewe should, if possible, be disposed of, and certainly no attempt made to inbreed to them.

Hybrids between He-Goat and Ewe. *A. Masala, Rivista di Zootecnia, Firenze,* 1928, *anno V, n.* 6, *p.* 206-211, 5 *figs.*—The existence of hybrids between he-goat and ewes has been much disputed. The author has been able to resolve this question in Sardinia, where the flocks of sheep frequently include a he-goat which mates successfully with the ewes if it has been separated when quite young from its dam, suckled by a ewe, and reared subsequently among sheep. The hybrids obtained by the author, although much resembling sheep, are dis-

tinguished by the following characteristics: shape and size intermediate between sheep and goat—wool with the characters of mohair—udder of the goat shape with divergent teats—milk capacity of female hybrids inherited from the goat strain. The hybrids, which are fecund to an unlimited degree, have indisputable practical value from their high milk yield and by their weight, both when young and when full grown, in excess of the Sardinian breed of sheep.

This account should be accepted with reserve.

Poultry.

Rate of Feather Growth in Barred Plymouth Rock Chicks. *By J. Holmes Martin.* 1929. *Poultry Science, Vol.* 8, *pp.* 167-183.—In Plymouth Rock chickens the males get their feathers more slowly than the pullets. The utility birds feather quicker than the exhibition, and are also quicker growers. There is linkage between the desired type of incisive barring and slow rate of feathering. Female chicks that feather slowly over their backs are poor winter layers. The paper generally shows in this breed the incompatibility of the exhibition standards with the economic.

ANIMAL NUTRITION.

Cane Molasses for Finishing Calves. *Culbertson, Evvard and Others. Iowa Agric. Expt. Stn. Leaflet No.* 27, *July* 1929.—Two experiments were planned to determine the economy of adding cane molasses to the ration of finishing calves. It has been claimed that the addition of molasses improves the palatability, and therefore increases feed consumption; that it stimulates water drinking and promotes greater gains.

In the first experiment the addition of 1 lb. of cane molasses to a standard ration had no effect on rate of growth, the control group putting on 2·42 lb. per head per day, as against 2·38 lb. by the experimental group. The food consumption was slightly higher in the experimental group, being 462 lb. per 100 lb. gain in weight, as against 456 lb. in the control group, the molasses group drinking 2 lb. more water per head than the control group.

Similar results were obtained in the second experiment. The gain in weight in the control group was at the rate of 2·32 lb. per head per day as against 2·31 lb. in the molasses group. In the same way the food consumption was greater in the experimental group than in the control group.

The Calcium-Phosphorus Relationship in the Nutrition of the Growing Chick. *Bethke, Kennard and Others. Poultry Science, Vol. VIII, No.* 5, *July* 1929, *p.* 257.—The authors have repeatedly noted that the addition of large amounts of calcium or phosphorus to the ration of growing chicks generally resulted in depressed growth and increased mortality, with a greater tendency to rachitic symptoms, and these observations led them to investigate the calcium-phosphorus relationship in the nutrition of the chicks.

In the first test six groups of day-old chicks (housed indoors) were fed a basal ration to which various amounts of calcium carbonate and sodium diphosphate were added. At the end of the fifth week of the experiment representative chicks from each group were killed for bone analyses. The remainder in the groups were continued till the thirteenth week, when they were killed and the bones analysed. The results show that the addition of increasing amounts of calcium carbonate to the basal ration did not markedly improve conditions for calcification. If, on the other hand, phosphorus was added in the form of sodium diphosphate there was a marked improvement in general health and calcification.

In another test groups of day-old chicks were fed indoors on a basal ration to which various additions of calcium carbonate and chick bone meal were added. Two lots of chicks received the same ration, one lot having in addition one per cent. cod-liver oil. Similar experimental procedure was adopted. The addition of small amounts of calcium carbonate to the ration had a beneficial effect on growth and calcification. When, however, the calcium-phosphorus ratio of 3·5 : 1 was exceeded by further additions of calcium carbonate, growth and the ash content of the bones was decreased and the inorganic phosphorus content of the blood was reduced. The addition of cod-liver oil improved growth and resulted in normal ash content of the bones, and here again the best result was obtained when the ratio calcium-phosphorus was about 3·5 : 1 or less. Similar results were obtained by the use of a high calcium limestone and steamed bone flour in place of calcium carbonate and chick bone meal.

The data indicate that the optimum ratio of calcium-phosphorus for the growing chick lies between 3 : 1 and 4 : 1, and that the requirements for the antirachitic factor are at a maximum at this relationship.

MACHINES AND IMPLEMENTS.

Development and Present Position of Mole Draining.—It frequently occurs that discoveries connected with rural engineering remain for a long time not generally recognised, or known to a limited circle only, until a combination of circumstances causes them suddenly to come to the front with a consequential general development of their application. This has proved to be the case with the mole-plough, which despite its signal importance was for a century and a half unknown outside its country of origin. The mole-plough was in fact an invention by Adam Scott in England towards the end of the eighteenth century, but it is only in quite recent years that any serious interest has been shown in it in any other country.

Draining with a mole-plough is really nothing but a kind of tubular draining without earthenware pipes, in which underground channels are formed by compression of the soil at a certain depth below the surface by means of a kind of plough with an extended flat beam carrying a share in the form of a hollow cylinder.

For the full success of this form of drainage a close soil without stones, such as is frequently found in England, is required. English soils have the additional advantage that frequently their surface is undulating so that they have a natural fall. Hence English mole-ploughs have no necessity for any special means of regulating the depth of working, and in consequence their construction is of a very simple character. This combination of favourable conditions explains the marked development of mole draining in England long before other countries with a different type of soil thought of taking advantage of the process. The problem of the increased cost of pipe-drainage in recent years has caused attention to be directed to this alternative and a beginning has been made in the Netherlands, where Professor Wisser as a result of his special studies has been able to discover a solution of the problem which can properly be applied to the level soils of his country. The Professor has designed a mole-plough adapted to local conditions in which the essential innovation consists in the control of the depth of the share, which provides the necessary fall of about 20 cm. per 100 metres. The depth may be as much as about a metre, but it is found somewhat difficult to maintain it accurately; hence it is necessary to determine the proper fall by staking and measuring more or less as in the case of ordinary drainage work. It has been suggested that a suitable fall can be maintained by means of two stakes to be kept in view as the mole-plough moves forward, but up to the present this method has not given very accurate results. If the depth is not carefully regulated, pockets are quickly formed in the subterranean channels, in which water accumulates and weakens the walls of the channels, with a tendency to cause an untimely breaking down by checking the circulation of air required to keep them in dry condition.

The power required for driving the mole-plough is very considerable, and hence the possibilities of mole-plough drainage could not be fully developed until the coming of the heavy tractor. The type which seems to be the most suitable is the tractor with a winch; as a rule it must be capable of developing at low speed a traction power exceeding 1,000 kg., which few tractors were previously able to reach. If animal traction is used, power transmission can be increased with the aid of anchors, cables and pulleys, while at the same time, as is highly desirable, diminishing the speed; thus, e.g., four strong horses are able to cut subterranean drains even in a close soil at a depth which may be as much as a metre.

Formerly the mole-plough was as a rule brought out of the ground by the action of a screw. A recent improvement has, however, been introduced by M. Flaba-Thomas (France) whereby it is quite easy to raise the share by removing a nut and hauling the plough. In France, where the example of the Netherlands has been followed in utilising this method of drainage, much attention has been paid, e.g. by Ringelmann, to the introduction of improvements. The English model has been taken as a basis and it has been supplied with a device for regulating the depth, but at the same time certain innovations have also been made, for example the most recent models supply automatically the required fall while in motion.

It is difficult to foresee how far mole drainage will justify all the hopes to which it has given rise. It may in any event be stated that, where it has been adopted, it has shown that it possesses distinct advantages over ordinary drainage methods. In the first place it is far less expensive and it allows the subterranean channels to lie much closer to each other, a matter of great importance in soils which require heavy draining; moreover it is an effective means of aerating the soil.

A decisive test is the life of the channels, which according to present experi-

ence varies enormously. In England as a rule the channels last for a very long time, and instances are known of systems established for forty or fifty years which are still in good condition. In the Netherlands, however, this "life" seems to vary with the nature of the soil and to be very short in the soft soils, still very moist, which have been embanked recently. Since complete drainage is particularly necessary in these conditions, efforts are being made to discover a means of giving greater durability to the channels made by the mole-plough by introducing earthenware drain pipes. Thus Fowler has invented a process which consists in driving the pipes into the channels by means of lever presses. In practice, however, this system has not proved very successful; not only is it by no means easy to lay the drains, but, when laid, they tend to have an irregular inclination to the prejudice of any satisfactory drainage. Hence Prof. Wisser has recently experimented with a process whereby the pipes are drawn through the soil over a series of planks behind the mole-plough. The trials so far made are full of promise, and justify the belief that this method is capable of development.

Results obtained in recent years suggest that mole draining, given certain mechanical improvements, may in practice be made to serve a number of purposes far exceeding those originally contemplated. The future must show to what degree further progress is still possible, but an excessive optimism would be unwise, since there is no gainsaying the essential condition that the soil must be free from stones.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in June, July and August 1929.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(*Compiled from Reports received from the Department's Market Reporters.*)

Description.	June.			July.			August.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ...	62 0	53 10	43 2	62 7	54 1	43 8	61 0	53 3	43 3
Cross-bred (Shorthorn)	57 7	50 0	40 7	56 9	49 4	40 4	54 10	48 2	40 7
Galloway	58 8	53 6	...	55 11	51 7	..	53 11	49 8	..
Ayrshire	55 6	43 0	34 0	54 0	44 0	34 2	51 3	41 6	31 6
Blue Grey	60 0	...	...	59 0	...	...	...	..	...
Highland	...	...	..	..	.	...	...	45 0	..
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	16	10	6	15½	10	6	13	10	..
†SHEEP—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb d.	Hoggs under 60 lb. per lb. d	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	16	14¾	11¼	15¼	13¾	10	14¾	13½	9½
Half-bred	15¼	14¼	11	14½	13	9¾	14¼	13	9
Blackface	15¼	13¾	11¼	14½	13	9¾	14¼	12¾	9¼
Greyface	15½	14½	11¾	14¾	13¼	10¼	14¼	12¾	9¼
Down Cross	15¾	14½	10¾	15	13¾	9½	15	13½	8½
†PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d	per stone. s. d.
Bacon Pigs	13 4	12 5	...	13 3	12 9	...	13 5	12 5	...
Porkers	13 10	12 8	..	13 9	12 9	...	13 11	12 10	...

* Live weight. † Estimated dressed carcase weight.

Live Stock: Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

Description.	June.			July.			August.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK:—									
Cattle—	Per head. £ s.	Per head. £ s.	Per head £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head £ s.	Per head £ s.	Per head. £ s.
Aberdeen-Angus:									
Yearlings	18 18	14 14	12 5	17 15	14 2	11 8	16 12	13 7	10 19
Two-year-olds ...	24 17	19 16	15 3	22 12	18 8	14 15	22 14	17 18	...
Cross-bred (Shorthorn):									
Yearlings	17 1	13 18	11 9	15 15	13 2	10 8	14 17	11 17	10 0
Two-year-olds ...	23 5	18 0	14 13	23 11	17 12	14 1	21 10	16 17	15 5
Galloway:									
Yearlings	14 3	...	...	13 8	...	...	13 18	...	...
Two-year-olds ...	22 5	17 3	...	22 10	17 17	...	...	19 10	...
Ayrshire:									
Yearlings	11 9	10 5	..	12 18	12 15	...	...	...	...
Two-year-olds ...	17 0	14 10	...	17 5	15 10	...	...	...	..
Blue Grey:									
Yearlings	...	...	...	...	...	...	...	12 0	...
Two-year-olds ..	...	...	..	..	...	...	...	...	...
Highland:									
Yearlings	10 3	8 2	6 1	...	8 0	6 0	...	..	...
Two year-olds ...	12 16	10 19	9 4	...	11 10	9 5	...	...	...
Three-year-olds ...	14 3	...	12 9	..	16 0	...	...	...	...
Dairy Cows—									
Ayrshire:									
In Milk	28 0	20 6	11 0	30 1	20 18	11 4	30 0	20 16	12 0
Calvers	28 2	20 11	13 15	28 0	21 3	14 2	28 2	21 0	14 5
Shorthorn Cross:									
In Milk	31 2	23 14	..	32 18	24 10	...	33 12	23 14	21 10
Calvers	28 13	21 6	16 10	30 4	22 1	17 5	30 10	22 7	17 8
Sheep—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	50 8	39 1	33 8	47 5	40 3	...		...	..
Half-bred Hoggs ..	61 4	50 7	...	63 6	55 0	...	65 3	...	...
Blackface Hoggs ...	39 4	31 8	...	41 0	29 3	...	...	..	...
Greyface Hoggs ...	55 3	44 7	40 6	50 6	41 0	...	46 1	38 0	...
Down Cross Hoggs	..	...	..	...	...	...	...	...	..
Pigs—									
(6 to 10 weeks old)	47 11	33 8	...	48 3	31 11	...	45 9	29 8	..

Dead Meat: Monthly Average Prices at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	Quality.	June. Dundee.	June. Edinburgh.	June. Glasgow.	July. Dundee.	July. Edinburgh.	July. Glasgow.	August. Dundee.	August. Edinburgh.	August. Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
Beef :—										
Home-fed—										
Bullock or Heifer ...	1	9	9⅛	10½	8¾	9⅛	10½	8¾	8⅞	10½
	2	8½	...	9⅜	8¼	...	9½	8¼	...	9½
Bull	1	7¾	7½	7⅝	7¾	7⅝	7	7¾	7½	7
	2	7	7	6⅞	6¾	...	6¼	6¾	...	6½
Cow	1	6⅞	6⅝	7	7	6½	6¾	7	6¼	6¾
	2	6	...	6⅜	6	...	6	6	...	6
Irish—										
Bullock or Heifer ...	1	...	...	9	...	...	8¾	...	...	8¾
	2	...	...	8½	...	...	8¼	...	...	8¼
Argentine Frozen—										
Hind Quarters ...	1	6½	7¼	6¾	...	7½	6¾	6	7½	6¾
	2	...	6⅝	6¼	...	6⅜	6¼	...	5⅞	...
Fore ,, ...	1	5	5½	5	...	5	5	4⅝	4⅞	5
	2	4⅞	4⅞	4½	..	4½	4½	..	4¼	.
Argentine Chilled—										
Hind Quarters ...	1	7½	7½	7	7⅛	7⅝	7¼	8⅛	8	7¼
	2	...	7	6½	7⅜	7	6¾	7¾	7⅝	6⅝
Fore ,, ...	1	5⅛	4⅞	4⅞	4¾	4¾	4¼	4⅞	4¾	4⅜
	2	...	4⅝	4⅜	...	4⅛	4	...	4½	4½
Australian Frozen—										
Hind Quarters ...	1	...	...	6¾	...	..	6¾	..	...	6¾
	2	...	...	6¼	...	...	6¼	...	...	...
Crops	1	...	...	5¾	...	...	5¾	...	..	5¾
New Zealand Frozen—										
Hind Quarters ...	1	...	...	6¾	.	...	6¾	.	...	6¾
	2	..	...	6¼	...	...	6¼	..	...	...
Fore ,, ...	1	..	...	4¾	...	...	5	..	...	5
Mutton :—										
Hoggs, Blackface ...	under 60 lb.	13	13⅜	13⅛	13	12⅝	12⅞	13	11⅝	12¼
	60 lb. & over	12	...	11⅛	12	...	10¼	12	...	10
,, Cross	under 60 lb.	13	13⅜	13⅛	13	12⅜	12⅞	13	11½	12¼
	60 lb. & over	12	...	11⅛	12	...	10¼	12	...	10
Ewes, Cheviot	1	...	9⅝	10⅝	...	8⅛	9⅛	..	7⅝	8⅛
	2	...	...	10⅛	...	...	8¼	...	...	7¼
,, Blackface ...	1	10	9⅜	10¾	10	8⅛	9¼	10	7½	8¼
	2	9	...	10⅛	9	...	8½	9	...	7¼
,, Cross	1	7¼	9⅜	8¼	8	8⅛	7½	8	7⅜	7⅜
	2	6¼	...	7¾	7	...	6¾	7	..	6⅝
Argentine Frozen ...	1	...	...	6	.	...	6	...	...	6
	2	...	...	5½	...	...	5¼	...	...	5½
Australian ,, ...	1	...	6½	5¼	...	6¼	5½	...	6⅜	5⅛
	2	...	5½	5	...	5½	5	.	5½	5
New Zealand ,, ...	1	...	..	6	...	...	6	...	...	5¾
	2	...	...	5½	...	...	5½	...	...	5
Lamb :—										
Home-fed	1	16½	15⅞	16⅛	14⅜	14	14	14	11⅞	12½
	2	14	...	15⅛	14	...	13	...	..	11⅝
New Zealand Frozen ...	1	...	10⅛	10¼	...	10	9⅞	.	9½	8⅝
	2	...	9⅛	9	...	9	8¾	...	8½	8
Australian ,, ...	1	...	...	9	...	.	8¼	...	...	8
	2	...	...	8½	.	...	8½	...	...	...
Argentine ,, ...	1	...	...	8	...	...	7¾	...	...	7
	2	...	...	7½	...	...	7½	...	...	...

EGGS: Monthly Average Wholesale Prices at Aberdeen and Glasgow.

(Compiled from Reports received from the Department's Market Reporters.)

Market.	Description.	Quality.	June.	July.	August.
			s. d.	s. d.	s. d.
Aberdeen.	Country ... ... per doz.	1	1 4	1 7	1 11
		2	1 2	1 5	1 8
	Duck .. ... ,,	1	1 5	1 7	2 0
		2	1 4	1 6	1 10
Glasgow.	Country .. ... per doz.	1	1 7	1 9	1 11
		2	1 6	1 7	1 10
	Irish .. .. per 120.	1	13 0	15 11	17 10
		2	11 3	14 1	15 7
	,, (Duck)... ... ,,	1	11 2	13 0	13 2
	Belgian ... ... ,,	1	12 5	13 5	14 6
		2	...	12 3	13 8
	Chinese, Black ... ,,	1	...	11 6	11 4
	Danish ... ... ,,	1	15 8	...	15 3
		2	12 0	.	14 7
	Dutch ... .. ,,	1	...	13 5	14 5
	Polish (Blue) ,,	1	9 4	10 9	11 4
		2	9 0	10 2	10 10
	,, (Red) ... ,,	1	8 5	10 0	10 4
	Russian ... ... ,,	1	...	11 9	10 8
		2	..	10 6	10 2
	Swedish ... .. ,,	1	15 8	13 6	14 11
		2	12 0	...	14 3

PROVISIONS: Monthly Average Wholesale Prices at Glasgow.

Description.	Quality.	June.	July.	August.
		s. d.	s. d.	s. d.
BUTTER:				
Irish Creamery ... .. per cwt.	1	171 6	172 0	170 6
,, ,, (Unsalted) ,,	1	176 6	176 0	174 3
Australian ... ... ,,	1	172 3	171 7	171 0
Danish ... ... ,,	1	174 6	178 0	177 9
,, (Unsalted) ... ,,	1	177 6	182 2	182 6
New Zealand ... . ,,	1	174 3	178 2	180 0
,, (Unsalted) ... ,,	1	177 0	181 10	184 3
Siberian ... ... ,,	1	...	166 0	165 6
Swedish ... . ,,	1	170 3	171 10	170 3
CHEESE:				
Cheddar ... ,,	1	124 0	96 7	96 9
	2	91 6	92 6	89 9
Cheddar (Loaf) . ,,	1	129 0	96 10	109 0
	2	96 0	..	...
Dunlop .. .. .. ,,	1	122 0	90 5	88 11
	2	86 6	80 10	82 0
Canadian .. .. ,,	1	...	98 7	98 0
New Zealand (Coloured) ,,	1	97 3	99 0	97 8
,, (White) ,,	1	96 9	97 7	95 6
HAMS:				
Irish (Smoked) ... ... ,,	1	210 0	212 0	212 0
	2	201 0	204 0	200 0
American, Long Cut (Green) ,,	1	121 9	119 7	119 6
American, Short Cut ... ,,	1	112 9	120 0	120 0
BACON:				
Ayrshire (Rolled) ... ,,	1	157 6	157 2	161 0
Irish (Green) ... .. ,,	1	141 0	142 0	142 6
,, (Dried or Smoked) ,,	1	148 6	148 10	149 0
,, (Long Clear) .. ,,	1	142 0	146 10	150 6
Wiltshire (Green) ... ,,	1	142 6	144 10	143 0
,, (Dried or Smoked) ,,	1	150 6	152 10	151 0
Danish, Sides ... ... ,,	1	117 0	127 7	130 0
Dutch (Green, Wiltshire Style) ,,	1	110 9	122 10	123 0
American (Long Clear, Middles, Green) ,,	1	102 0	107 7	107 3
American (Short Clear Backs) ,,	1	102 6	105 7	104 6

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Reports received from the Department's Market Reporter.)

Description.		Quality.	JUNE.	JULY.	AUGUST.
FRUIT:—					
Apples—			s. d.	s. d.	s. d.
British—					
Cooking ...	... per cwt.	1	...	...	28 0
Imported—					
American ...	... per barrel.*	1	...	...	27 0
Australian ...	... per case.**	1	16 0	...	...
New Zealand	... ,,	1	16 0	24 4	21 2
Cherries, British	... per lb.	1	..	0 8	...
Currants, Black	... ,,	1	...	0 8	0 4½
Damsons . .	... ,,	1	...	..	0 2½
Gooseberries, British ...	,,	1	..	0 2¼	0 4
,, Imported	,,	1	...	..	0 1¾
Greengages, Imported ..	,,	1	...	...	0 7¾
Plums, British, Victoria	,,	1	...	...	0 7½
,, ,, Egg ...	,,	1	...		0 2¾
,, Imported ...	,,	1	...	...	0 4½
Raspberries	,,	1	..	1 0	0 7½
Strawberries, *Scottish* ...	,,	1	..	1 3	. .
Pears—					
British ...	... per crate.†	1	..	...	10 6
French ...	... ,,	1	...	...	12 0
Californian ...	... per case ‡	1	..	..	12 6
Australian ..	... per tray.††	1	...	9 0	...
VEGETABLES:—					
Beet	... per cwt.	1	7 0	5 4	7 0
Cabbage, Coleworts	... per doz.	1	1 5	1 8	1 7
Carrots, *British* ...	... per cwt.	1	8 0	10 0	8 3
Cauliflowers—					
Broccoli, *Cornish*	... per doz.	1	5 0	...	...
Other British	... ,,	1	5 0	5 3	3 11
French . ..	.. ,,	1	5 0	...	...
Dutch	... ,,	1	5 0	4 0	4 6
Celery	... per bunch.	1	...	...	2 6
Cucumbers, *English*	.. per doz.	1	6 3	4 10	5 6
Leeks	per doz. bunches.	1	3 0	.	4 0
Lettuce, Cos ...	... per doz.	1	1 6	1 4	1 2
,, Cabbage ...	,,	1	1 6	1 2	1 2
Onions, *Valencia*	... per case. §	1	12 0	10 0	9 11
,, *Egyptian*	.. per bag.¶	1	8 2	8 0	...
,, *Spring* ...	... per bunch.	1	0 5	0 4¾	0 4¾
Parsley	... per cwt.	1	16 0	16 0	15 0
Peas, Home grown	... ,,	1	8 0a	16 8	14 6
Radishes	per doz. bunches.	1	1 11	1 6	1 6
Rhubarb	... per cwt.	1	3 6	3 2	4 9
Spinach	.. ,,	1	22 0	22 0	22 0
Tomatoes, *Scottish*	... per lb.	1	1 0½	0 9¼	0 6¾
,, *English* ...	,,	1	0 10	0 8	...
,, *Channel Islands*	,,	1	0 10	0 7½	0 5
,, *Canary* ..	,,	1	0 8	...	...
Turnips	... per cwt.	1	5 6	3 9b	4 0

* 140 lb. (approx.). ** 40 lb. (approx.). † 100 pears. †† 84 pears. ‡ 72 pears.
§ 9 stone. ¶ 1 cwt. *a* per bag (40 lbs.). *b* per dozen bunches.

POTATOES: Monthly Average Wholesale Prices at Aberdeen, Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Department's Market Reporters.)

MARKET.	Quality.	FIRST EARLIES.	SECOND EARLIES	LATE VARIETIES. Red Soils. Golden Wonder.	LATE VARIETIES. Red Soils. Other.	LATE VARIETIES. Other Soils. Golden Wonder.	LATE VARIETIES. Other Soils. Other.
		£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
JUNE.							
Aberdeen, per ton	1	...	..	...	..	4 15	2 16
Dundee ,,	1	...	.	...	..	...	2 10
Edinburgh ,,	1	10 5	..	.	.	...	.
Glasgow ,,	1	...	...	7 0	.	5 4	2 9
JULY.							
Aberdeen ,,	1	6 0	.	...	...	...	2 9
Dundee ,,	1	5 7	..	...	...	...	2 10
Edinburgh ,,	1	5 13		..	.	...	...
Glasgow ,,	1	4 15	4 5	6 13	...	4 3	2 12
AUGUST.							
Aberdeen ,,	1	4 10	3 15	...	..		.
Dundee ,,	1	3 18	3 17	..			..
Edinburgh ,,	1	3 18	3 10	..		.	...
Glasgow ,,	1	4 0	4 10	...	.		

ROOTS, HAY, STRAW, AND MOSS LITTER: Monthly Average Prices at Aberdeen, Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Department's Market Reporters.)

MARKET	Quality.	ROOTS. Carrots.	ROOTS. Yellow Turnips	ROOTS. Swedes	HAY. Rye Grass and Clover	HAY. Timothy	STRAW. Wheat	STRAW. Barley	STRAW. Oat	MOSS LITTER.
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
JUNE.										
Aberdeen, per ton	1				96 8*	...		.	29 2a	...
‖ Dundee .. ,,	1				140 0† 130 0‡	.	80 0		80 0	57 6§
¶ Edinburgh ,,	1			..	135 0† 130 0‡	...	60 0	..	60 0	..
‖ Glasgow ,,	1				123 9†	128 9†	60 0		65 0	36 3§§
JULY.										
Aberdeen ,,	1				90 0*	.			29 2b	...
‖ Dundee ... ,,	1	.			140 0† 130 0‡		80 0	.	80 0	57 6§
¶ Edinburgh ,,	1				135 0† 130 0‡	.	60 0		60 0	..
‖ Glasgow ,,	1		..		125 0†	130 0†	60 0	.	65 0	35 0§§
AUGUST.										
Aberdeen ,,	1	...	...	..	78 9*	.			27 6b	...
‖ Dundee ... ,,	1	...	.	...	140 0† 94 5‡	...	76 3		76 6	57 6§
¶ Edinburgh ,,	1		.	..	120 0† 92 6‡	..	58 9	.	58 9	[illegible]
‖ Glasgow ..	1	.	..		93 2†	94 5†	60 0		65 0	35 0§§

‖ Baled Straw delivered.
‡ Delivered loose.
* Ex stack, baled.
¶ Bunched Straw delivered
§ Foreign, delivered in town.
a Baled, on rail.
† Delivered baled.
§§ Home (in 1½ cwt. bales).
b Ex stack, loose.

FEEDING STUFFS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	June.		July.		August.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	12 8 2	12 0 0	12 13 6	12 5 0	13 10 0	13 1 3
Foreign	12 5 0	...	12 7 3	...	12 18 2	...
Decorticated Cotton Cake	11 5 4	...	11 9 6	...	11 15 0	...
Undecorticated do.—						
Bombay (Home-manufactured)...	7 5 0	7 0 0	7 1 8	6 19 6	8 1 8	7 8 2
Egyptian (do.)	7 12 6	7 10 0	7 14 6	7 7 6	8 9 8	...
Palmnut Kernel Cake	11 0 0	...	11 0 0	...	11 2 6	...
Soya Bean Cake ...	13 3 9	11 18 4	12 18 0	11 17 6	13 5 0	11 17 6
Coconut Cake ...	11 12 6	..	11 10 0	...	11 12 6	...
Groundnut Cake, Undecorticated—						
(37 per cent. Oil and Albuminoids)	9 5 0	..	9 7 6	...	9 11 3	...
(40 per cent. do.)	9 10 8	9 15 0	9 11 0	9 15 0	9 17 6	9 16 3
Maize Germ Cake—						
Home	11 11 11	...	11 9 3	...	11 11 11	...
Foreign	11 5 0	...	11 4 0	...	11 10 0	...
Maize Germ Cake Meal	10 8 9	..	10 10 0	...	10 5 0	...
Rice Meal	7 18 9	7 5 0	7 16 0	7 5 0	7 17 6	7 11 3
Bean Meal	12 1 3	11 17 6	12 0 0	11 18 0	11 16 11	12 0 0
Barley Meal ...	10 3 2	9 15 0	10 4 0	10 5 0	10 7 2	10 0 0
Fish Meal	19 7 6	18 15 0	19 5 0	19 0 0	19 7 6	18 10 0
Maize Meal—						
Home-Manufactured	10 10 0	9 15 0	11 0 0	10 8 0	11 5 8	10 13 2
South African—						
(Yellow) ...	10 9 1	...	10 17 6	...	10 15 8	..
(White) ...	10 0 0	...	10 6 6	...	10 6 11	...
Locust Bean Meal (Fine)	10 12 6	9 8 9	10 12 6	9 12 6	10 8 2	9 6 3
Maize Gluten Feed (Paisley) ...	9 15 0	..	9 15 0	...	9 15 0	...
Maize—Plate ...	9 12 6	9 0 0	10 3 3	9 11 6	10 5 0	9 17 6
Do. American ...	9 13 5	..	10 2 0	...	10 9 1	...
Oats—Home ...	9 7 6	9 0 0	9 8 9	9 7 0	9 11 11	9 7 6
Do. Plate ...	8 11 3	..	8 17 6	...	9 8 2	...
Do. Canadian, No. 1	...	...	...	...	10 0 0	...
Do ,, No 2	8 11 11	..	9 1 6	...	9 10 0	...
Barley Feeding (Home)	10 3 9	9 0 0	10 4 3	9 8 9	9 17 6	...
Do. Bran ...	9 17 6	..	10 1 0	...	9 13 9	...
Wheat—						
Home	9 12 6	9 0 0	10 19 9	10 12 0	12 13 2	11 2 6
Poultry	9 11 3	9 0 0	10 10 9	10 12 6	11 15 0	11 3 4
Imported... ...	8 10 8	...	9 10 3	...	10 8 9	...
Middlings (Fine Thirds or Parings)	8 3 2	7 0 0	8 5 9	7 16 0	9 0 8	8 13 9
Sharps (Common Thirds) ...	6 17 6	6 10 0	7 6 6	6 17 0	7 13 2	7 8 9
Bran (Medium) ...	6 11 11	5 19 5	7 3 3	6 16 0	7 9 1	7 6 3
,, (Broad) ...	6 14 5	6 15 0	7 6 0	7 11 0	7 12 10	8 3 9
Malt Culms... ...	7 17 6	7 15 0	7 16 6	7 12 3	7 12 6	7 12 6
Distillery Mixed Grains—Dried	...	9 5 0	...	9 5 0	9 16 8	9 6 11
Brewers' Grains—						
Dried	9 0 11	7 16 11	8 15 6	7 17 0	8 13 2	8 0 0
Distillery Malt Grains—Dried	8 17 10	...	8 10 0	...	8 10 0	...
Crushed Linseed ...	21 0 0	...	21 8 0	...	23 1 3	...
Locust Beans,						
Kibbled and Stoned	9 10 0	8 17 4	9 10 0	8 17 6	9 10 8	8 17 5
Beans—China ...	11 2 6	...	11 3 6	...	10 15 0	...
Do. Sicilian ...	11 0 8	...	11 1 9	...	10 7 10	...
Pease, Calcutta (White)	14 2 6	..	15 0 0	...	15 5 0	...
Feeding Treacle ...	7 1 11	6 15 0	7 0 0	6 17 0	7 0 8	7 5 0
Linseed Oil, per gall.	0 4 0	...	0 4 2	...	0 5 9	...

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Reports received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	June. Glasgow.	June. Leith.	July. Glasgow.	July. Leith.	August. Glasgow.	August. Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda § ...	N. 15½	10 12 0	10 13 0	10 12 2	10 13 0	10 13 0	9 9 0
Nitrochalk ‖ ...	N. 15½	10 0 0	...	10 0 0	...	...	...
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	10 12 0	10 13 0	10 7 5	10 13 0	9 9 0	9 9 0
Superphosphate ...	P.A. 13·7	*a*2 7 6	2 12 6	*a*2 7 6	...	.	..
,, ...	,, 16·0	*a*2 12 6	2 17 6	*a*2 12 6	...	...	...
Ground Mineral Phosphate † ...	P.A. 25½	2 7 6	...	2 7 4	...	2 6 6	2 6 6
Kainit (in bags) ...	Pot. 14	3 7 6	3 3 9	3 7 6	...	...	3 2 6
Potash Salts ...	Pot. 20	3 17 6	3 12 6	3 17 6	...	...	3 10 0
,, ,, ...	Pot. 30	5 5 0	5 1 3	5 5 0	...	...	4 17 6
Muriate of Potash... (on basis of 80 per cent. purity)	Pot. 50	9 12 6	9 2 6	9 12 6	...	...	...
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 15 0	11 3 9	11 15 0	...	...	...
Steamed Bone Flour	N. 0·8 P.A. 27½/30	6 5 0	6 0 0	6 5 0	...	...	...
Bone Meal, Home *a*	N. 3·3 P.A. 22·9	7 15 0	...	7 15 0	...	...	..
,, ,, Indian *a*	N. 3·75 P.A. 22·9	9 5 0	...	9 5 0	...	...	...
Basic Slag * ...	P.A. 11	2 1 9	...	2 1 9	.	.	..
,, ,, * ...	,, 12	2 2 9	...	2 2 9	...	...	...
,, ,, * ...	,, 13	2 3 9	...	2 3 9	..	..	...
,, ,, * ...	,, 14	2 5 9	...	2 5 9	...	..	..
,, ,, ** ...	,, 14	...	2 12 6	...	...	...	...
,, ,, * ...	,, 15	2 7 9	...	2 7 9	...	...	...
,, ,, ** ...	,, 16·5	...	3 7 6	...	...	...	...
,, ,, *b* ...	,, 18	...	3 12 6	...	...	...	...

Abbreviations:—N. = nitrogen ; P.A. = Phosphoric Acid ; Pot. = Potash.

* ·75 per cent. to 80 per cent Citric Soluble Phosphates; carriage paid in 6-ton lots to Lanarkshire and Renfrewshire stations. ** At Leith.

† Fine grist 80 per cent. fineness through standard 100-mesh sieve.

§ Carriage paid in 6-ton lots. ‖ Carriage paid in 2-ton lots.

a. F.o.r. Glasgow. *b.* Belgian slag at Leith.

Printed under the authority of HIS MAJESTY'S STATIONERY OFFICE
By J. Skinner & Co., Ltd., Thistle Street, Edinburgh.

(8492.) Wt. 10841/1238. 1375 + 11, pp. 445-457. 10.29. J.S.&Co.,Ltd. G.19.

INDEX TO VOL. XII—1929